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Electrical World

1874~1924

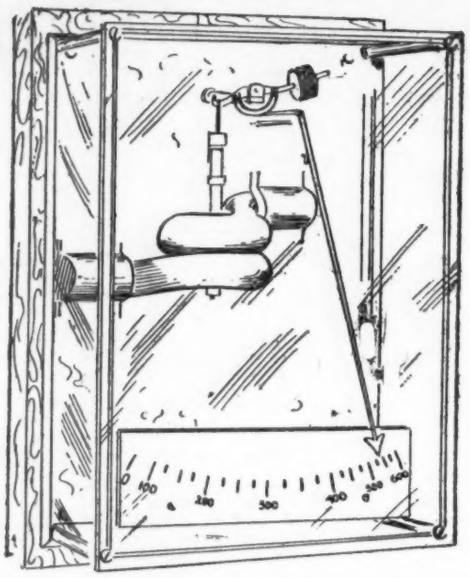
TO PICTURE the pathway along which electricity has made such astonishing progress to pay tribute to the men of the electrical industry who in half a century have from a dream wrought for mankind a better civilization and to record with pride the acknowledgment by these men of its own part therein the Electrical World issues this

Semi-Centennial Number

McGraw-Hill Company, Inc. *September 20, 1924*

In Two Sections · Section One

Forty Years of Instrument Progress



Typical of the Plunger Type of Switchboard Ammeter of 40 Years Ago

These ammeters were cumbersome and crudely designed with heavy moving systems entailing large friction losses.

The full line current passed directly through the instrument which required bringing the main current connection directly to the instrument.

Contrast this instrument of 40 years ago with the modern types of Weston Instruments which are compact, accurate, rugged, have exceedingly small power consumption and are very economical to buy and use.

A Modern Switchboard Instrument of Today

A most recent contribution to the instrument art — Rectangular Instruments for Switchboard use.

These instruments are compact and neat in appearance and present a clean-cut arrangement on the rear of the board as well as on the front. The wide open scales drawn with bold types of arcs and figures gives splendid illumination and great visibility.

A few of the outstanding Weston contributions to the advancement of the instrument makers' art are:

WESTON CELL — the recognized standard of E. M. F. the world over.

ALLOYS — negligible and negative temperature coefficient alloys which form the basis of all certified resistance standards, and are of prime importance in all modern electrical measuring instruments.

PERMANENT MAGNET INSTRUMENT —In 1888 the Weston Electrical Instrument Company brought out the first permanent magnet pivoted movable coil type of direct current instruments. The prototype of all satisfactory direct current instruments of today.

EXTERNAL SHUNTS permitting the remote location of instruments from bus-bars and saving enormous investments in copper, thus revolutionizing the design of switchboards themselves.

ELECTRODYNAMOMETER INDICATING INSTRUMENTS—The generally established principle of operation of all highest grade alternating current instruments for switchboard or laboratory service.

THIRTY-SIX YEARS of pioneering and manufacturing scientifically designed and constructed electrical instruments has made it possible to obtain Weston indicating D. C. instruments of the double pivoted type with wide ranges of sensitivities varying from .000025 ampere to 40,000 amperes and over, to give full scale deflection.

EVER SINCE ITS FIRST INCEPTION, the Weston Electrical Instrument Company has rightfully been regarded as an originator and the foremost contributor to the art of electrical measurements.

Its products are the recognized standards the world over.

Weston Electrical Instrument Co., 13 Weston Ave., Newark, N. J.

Electrical Indicating Instrument Authorities Since 1888

WESTON

STANDARD - The World Over

ELECTRICAL WORLD

The consolidation of Electrical World, Electrical Engineer and American Electrician

PUBLISHED BY McGRAW-HILL COMPANY, INC.

W. H. ONKEN, JR. EDITOR — HAROLD V. BOZELL EDITOR

Volume 84 — NEW YORK, SATURDAY, SEPTEMBER 20, 1924 — *Number* 12

Our Fiftieth Anniversary

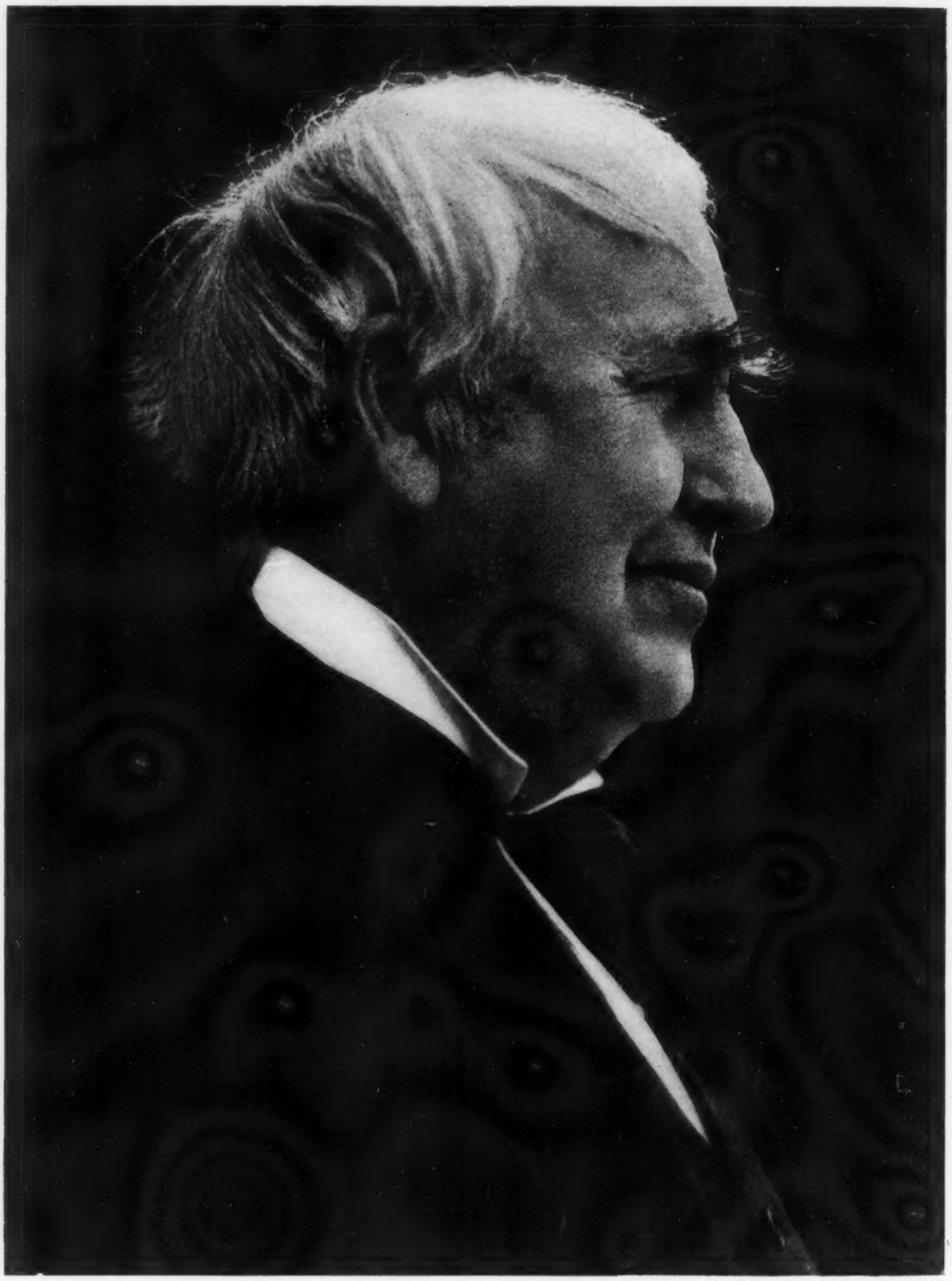
WITH this issue the ELECTRICAL WORLD celebrates its semi-centennial. Fifty years, to be sure, is not a long time; but in fifty years the nation has risen to triple its former strength and in fifty years the industry which the ELECTRICAL WORLD represents has grown a hundredfold. Then it was a dream, a nebulous fancy, without form or purpose. Now it is one of the basic industries of the country, destined before long to become the largest because it pervades all others.

Now, age of itself signifies nothing unless it be signalized by accomplishment. The ELECTRICAL WORLD was identified with the industry before electric lighting came into general use. It witnessed the rapid evolution of that industry from practically nothing to its present vast proportions. Well might it say with Virgil: "All of these things I saw, and a great part of them I was." And yet while the editors and publishers realize the splendor of the tradition and of the inheritance which they hold in their hands, they do not associate the ELECTRICAL WORLD with age; it is, they know, still in the vigor of youth.

History teaches us that change is inevitable and that progress is eternal. What vast changes have been made in the ELECTRICAL WORLD from the days of the *Operator* to the present time, and what accomplishments and progress have been recorded! Through all the transient and rapidly shifting phases of the science and art the publication developed with the industry it serves, and always maintained its position of pre-eminence. Always it has renewed itself. Always it has known how to adapt itself to changing and oftentimes perplexing conditions. Bringing inventive intelligence and suppleness of mind to bear upon its problems, it has seen them vanish one by one as it advanced. If it has modified its method, if it has altered its mode of life, it has always preserved beneath the outward semblance of change the institutional characteristics of virility, stability, independence and idealism.

To trace an art from its inception, to note changes and improvements as they occur in it, to follow its ramifications from the realm of speculation to the abode of fact, to correlate its achievements with advances in allied and kindred arts, and to keep the industry enthusiastic and enterprising, is not an easy task for any publication. None could reach or long hold the place occupied by the ELECTRICAL WORLD unaided. It is the hearty support and good will of its hosts of readers and friends throughout the world that have made it a factor in the industry to which its loyal service has been given. The industry's cause has always been the ELECTRICAL WORLD'S cause, and for the industry's sake no effort is too great, no duty too onerous. But it takes time to make friends and age to build tradition. We look to gardens old and matured, to soil that has bred fine blossoms to breed them again, knowing that the garden which has been well tended will yield the choicest flowers.

To have been a part of the electrical industry, to have helped in its upbuilding and to have recorded its progress has been the privilege of the ELECTRICAL WORLD for half a century. How well it has fulfilled its mission others must tell. Men prominent in the industry who in this number trace the developments of the past five decades point also to the part the ELECTRICAL WORLD has played in them. The tributes contained in articles and letters are flattering indeed. They make it unnecessary for us to say much in our own behalf; for no better or more tangible evidence of worth is obtainable than the commendation and approval of readers. We appreciate these tributes and shall cherish the approbation expressed in them because it imparts new courage and inspiration and deepens in us a sense of greater things yet to be.



PHOTOGRAPH BY JOHN E. GARABRANT

Thomas Alva Edison

The "Grand Old Man" of the electrical industry whose surpassing vision and inventive genius have made the whole world forever his debtor

Ideals of Industrial Journalism

Their application during fifty years of publishing service to the electrical industry

By James H. McGraw

President McGraw-Hill Company, Inc.

NOT many years ago any assertion of the essential idealism of the American character as manifested in the industrial life of the nation would have aroused laughter both abroad and at home. Today thoughtful men, with clearer insight, penetrate the envelope of apparent selfishness and see that not money, nor other material reward, has been the mainspring of American industrial energy, but the ambition to produce superior products—which is a spark of the artist's divine fire—and the desire to create organizations that, living after their founders, will constantly render new and better services to mankind. To produce steel at lower cost is to serve man better; to make motor cars that the poorest may buy is to broaden the outlook of millions; to generate electrical energy cheaply is to change hovels to homes and to lift burdens from the backs of men. Ultimate ends such as these are the deep-lying stimuli of American industrial life.

Perhaps the slowness to recognize the idealistic spirit that permeates the industrial structure was due in the past to the non-vocal quality of business—to its lack of mediums for the expression of its aims.

Today industry has found its voice. It has found it in the national and regional conventions that have become so vital a part of its life. It has found it to an even greater degree in the industrial and technical press that has grown from infancy to manhood in a generation. As the voice of industry, it is the mission of this press not only to record and interpret the doings of industry but to proclaim and make evident the ideals that underlie industrial service. To do this industrial and technical journals must be something more than publications run solely for profit. They must, if they are to fill their legitimate place, have their own ideals, in correspondence with those of the industries they serve, and adhere unflinchingly to them.

Some of these ideals will at once suggest themselves. Integrity, efficiency, service, for instance, are the ideals of every honest business. That the publishers, managers and editors of industrial journals have them ever in mind needs not the saying, but perhaps there may be a few aspects of this nationally accepted business idealism which have a special application to industrial publishing and which may be briefly dwelt upon without unduly expanding the obvious.

First among such ideals is independence—the determination of a journal to be its own master, to have no other guides for its opinions and policies but truth and the sound interests of the field it serves. Many men will try to bend its policy to serve their selfish interests, but the publisher who stands fast, who protects the integrity of his reading pages, will have the satisfaction of knowing that he has kept faith with his conscience and his readers, and that those whom he has courageously served will, by their support and confidence, crown his journalistic efforts with success. The right-minded publisher holds that he has a covenant with his subscribers—a covenant to be honest with all and to do harm to no one who is pursuing an honest course. From that covenant he will not depart.

An industrial journal so controlled at once commands respect. If it is to exert influence as well, it must also command ability of a high order. Managerial skill, necessary as it is, will not alone suffice. There must be that rare editorial power, compounded of knowledge, alertness and foresight, that can keep its finger on the pulse of an art and an industry, analyze achievements and comprehend tendencies, that never fails to distinguish rightly between the less and the greater, and that mistakes neither charlatanism for genius nor genius for charlatanism. Not even the editor of an industrial paper, of course, can become infallible, and when he is in doubt he does right honestly to say so; but it is his part to bring to his task of interpretation and guidance all that industry, application and constant contact with his field can supply.

Industrial Press as an Educator

The educational mission of the industrial paper fills an important part in its ideals. To record and interpret all that goes on in its field from day to day, to draw upon the history of the art with which it is connected for instruction and encouragement, to review the past at suitable intervals, to stimulate research and provide a medium for recording its results are vital functions. Nine-tenths of education springs from the contact of mind with mind—the other tenth a man may get for himself if his own mind is fertile enough. Mental contact may come through either the written or the spoken word. In our day it is the written word that plays the lion's share, and a technical paper that proves unable to teach not only the freshman and the industrial neophyte but, on occasion, the master scientist, the veteran engineer and the industrial leader is not fulfilling its mission. To do this the editor does not need to know more than all others; he needs the instinct to recognize achievements in embryo, the insight to divine where knowledge lies, and the tact, where necessary, to coax its possessor into utterance.

Breadth is another aspect of idealism. The scope of every industrial art is ample enough to justify no little subdivision, and there is danger that the technical paper may, on the one hand, spread itself too thin or, on the other, become so intensively specialized that its interest will be limited and its influence narrow. The electrical field, for instance, in all its engineering, manufacturing, financial and commercial ramifications, is a particularly widespread one. No one journal could, without becoming unwieldy, exhaust this field in all its aspects; but one well-balanced and ably conducted paper can provide a survey of the important and effective developments of this profound science, this intricate art, this pulsating industry, that will render it indispensable in its wide sphere.

The ELECTRICAL WORLD had its genesis half a century ago in a little sheet founded to help and to amuse telegraph operators. It was not merely a social and craft mouthpiece, however. Early in its career it included among its contributions technical articles covering the electrical art as it was at that day, and it numbered among its supporters Thomas A. Edison and other men who have come up from the telegrapher's key to distinction or fame. The paper was forced to grow with its growing field. Through all the changes of name and enlargements of scope that have marked the evolution of the *Operator* into the ELECTRICAL WORLD of today this necessity has persisted. Through the period when the technical development of the art absorbed the thought and dictated the growth of the embryonic industry, through the later period when central-station service sprang up and urban power-house and distribution-line problems were of dominating importance, on through all the shifting phases to the present period of vast commercial growth, of long high-tension lines, of interconnection, of consolidation, of rural service, of intensive water-power development wherever water power can be made to pay, the ELECTRICAL WORLD has passed. If it can rightly claim that it has filled its field and discharged its mission, the claim must be based, not on any occasional special feature or brilliant article, but on proof that it has kept step steadily and constantly with the advance of the industry it serves, has neglected none of the regimental divisions of that electrical army and has been the standard bearer not of a troop but of the whole advancing host.

To work for the unification of the industry whose spokesman it aims to be is, indeed, one of the most important among the missions of the technical and industrial journal. To further great modern undertakings, the pure scientist, the inventor, the engineer and designer, the financier, the manufacturer, the executive, the merchant, the salesman, the contractor must work side by side, and the interest of one is, in the final analysis, the interest of all. Commercial ramifications cannot be ignored; progress is built on profit. To promote good understanding, eliminate friction and inculcate a sense of solidarity among all the branches of an industry—these must be included in the high aims that the industrial journal keeps before it. By this exacting standard the success of the ELECTRICAL WORLD must be measured.

To achieve all these ends, and thus properly to serve its ideals, an industrial journal must be interesting. That is a hackneyed adjective, applied to everything from a total eclipse of the sun to a comic film, but there seems no other. To be interesting an industrial paper must be well written and well printed. It is not enough that nouns and verbs agree and that demonstrations and descriptive articles follow a logical order. Into its demonstrations and its descriptions, its Q.E.D.'s and its Q.E.F.'s, must be let a little light and color. A suggestion of the grace of literature must where possible blend with the austerity of its science, some byplay of wit and homely wisdom temper the solidity of its data and its dicta. Appropriate illustrations, well-considered headlines and tasteful typography must give to its pages that readable aspect upon which even engineers in these times insist. Frivolity, slang and personalities are properly excluded. Dignity is essential. But the ideal industrial journal will not forget that industrialists and technicians, too, are men and that nothing that concerns mankind can be foreign to them.

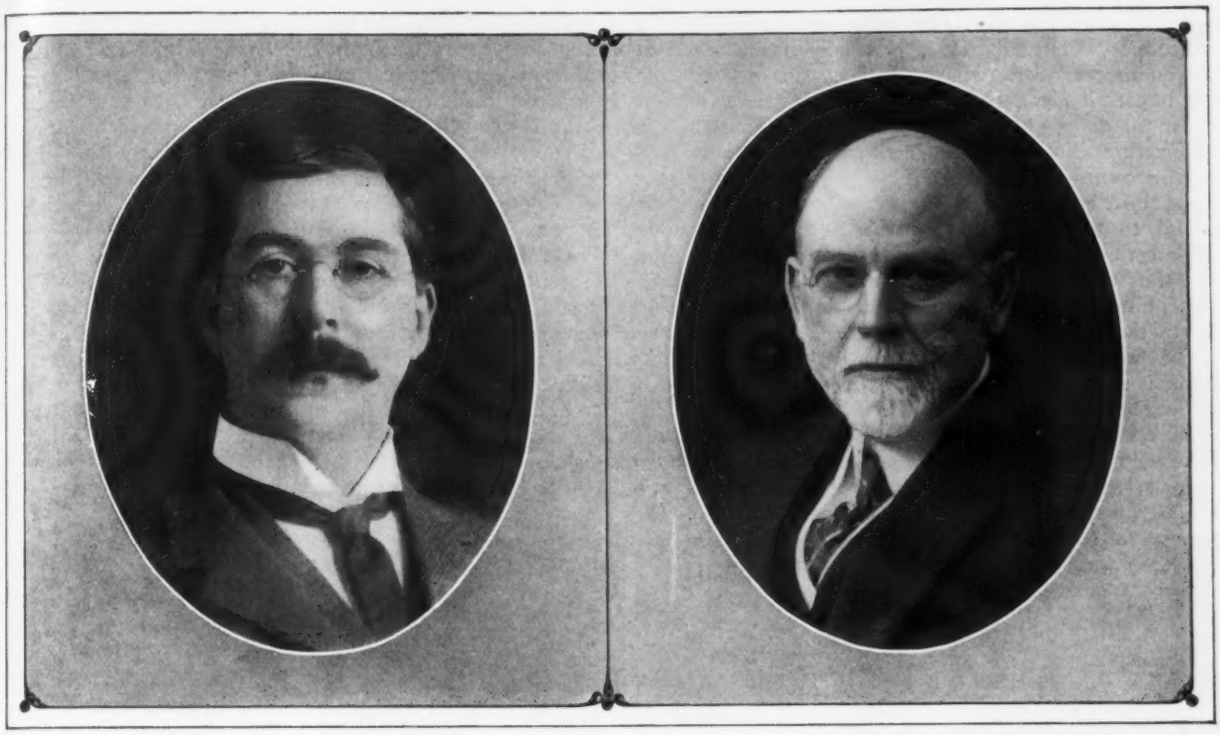
Journalistic Virility

But this is not all. A paper may be carefully edited, cover its field broadly and be put together in an attractive manner, it may be able to instruct, and yet be lacking in authority and influence. It will then be a good paper, but not a great one. It will follow, not lead. Mild universal approbation is no more the token of the highest success than is a sure and constant balance on the right side of the ledger. The publisher with ideals will not be satisfied with any routine success achieved at the expense of virility. He will exercise and insist on courage wherever courage is called for in preference to "playing safe." He will not rest content unless the business and editorial policies of his journals challenge the respect and confidence of the industries his journals serve. He will covet for these journals an authority that will cause their managers and editors to rank as chiefs and not subalterns in the field. Theirs and his is the duty to point to new paths to be blazed, to erect warning signs where danger threatens, to divine alike what is obsolete and what is rash, and to keep resolutely abreast of progress wherever it may lead.

This is not the path of the amateur or the dilettante. It is a task for able and earnest men by whom the industrial journal is visioned as a mighty factor in industry's and in the nation's life. Such men, if gifted with foresight, persistence and acumen, the ability to concentrate and to co-operate, knowledge, skill, tact, persuasiveness and a capacity for work, will find the formula for translating idealism into reality.

Needless to say, the publishers, editors and managers of the ELECTRICAL WORLD have for fifty years held these ideals before them. Judgment as to the extent to which they have succeeded must rest with the readers—with the engineers, the manufacturers, the financiers and managers of industry whom the paper has served. Those who have had a part in making the ELECTRICAL WORLD can honestly say that the effort has been painstaking, earnest and constructive. The paper has striven to make a worthwhile contribution to the development of the art, to be helpful to those who were doing the day's work or carrying the banner of progress, to raise the practices of the industry at every point to the highest possible level, and to bring together in understanding and sympathetic cooperation all who were contributing to the development of this marvelous electrical age. Its task has been pursued with enthusiasm—an enthusiasm born of the desire to see electricity contribute a maximum to human comfort and welfare.

If those who have helped make the ELECTRICAL WORLD were to indulge in criticism, it would be, passing over minor faults, that their enthusiasm has not been high enough, their vision not sufficiently exalted. For the future they would pray an illumination of mind to compass in some degree the possibilities of this mighty servitor of mankind whose development it has been the privilege of the ELECTRICAL WORLD to chronicle and to herald during these fifty wonderful years.



W. J. Johnston

James H. McGraw

The Men Who Have Built the "Electrical World"

and the story of its building

By Harold V. Bozell

Editor Electrical World

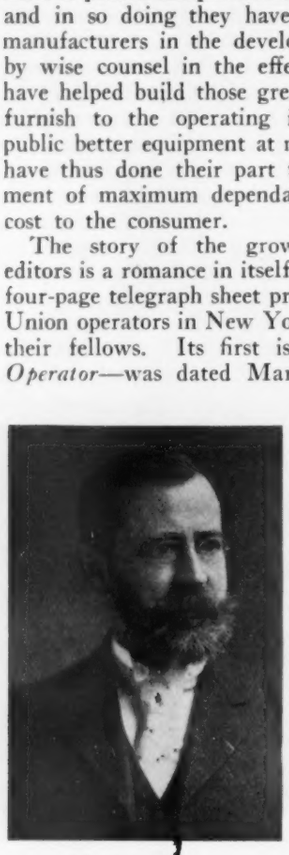
BEHIND every institution stand individuals. Into every achievement have gone individual toil and individual brains. Of nothing is this truer than in the building of a great and efficient industrial journal like the ELECTRICAL WORLD. Such a paper is the result of the continuous and unselfish work of men of initiative and foresight, of imagination and courage. The story of the growth of the paper lies largely in the story of the activities and the personalities of the men who built it. To them is due the credit—and the glory—of having created, step by step, the periodical which has played so important a part in the upbuilding of the industry of which it is the outstanding exponent. Started at a time when industrial publishing was young, and in what (telegraphy aside) might be called the prenatal period of the electrical industry, the paper which became the ELECTRICAL WORLD has grown under their guidance to be at once the arterial and the nerve system of that industry—constantly supplying new energy and at the same time responding to every impulse.

For the ELECTRICAL WORLD as it is today major credit is due to the business genius, the inspiration and the high ethical standards of James H. McGraw, the head of the publishing house which for a quarter of a century has owned and published the paper. Yet to its originator, the late W. J. Johnston, who took it through the first half of its existence and built a groundwork of substantial breadth and excellence, full credit must also be given. Second only to the two publishers who have guided its destiny come its editors. Among those who have won editorial prestige for the paper there stand out such men as W. D. Weaver, the first editor of the paper in its present form; Dr. Louis Bell, T. Commerford Martin, Carl Hering, C. O. Mailloux, A. S. McAllister, Frank F. Fowle, F. M. Feiker and more recently W. H. Onken, Jr., at present its senior editor, who has seen longer continuous service with the publication than any one else except Mr. McGraw.

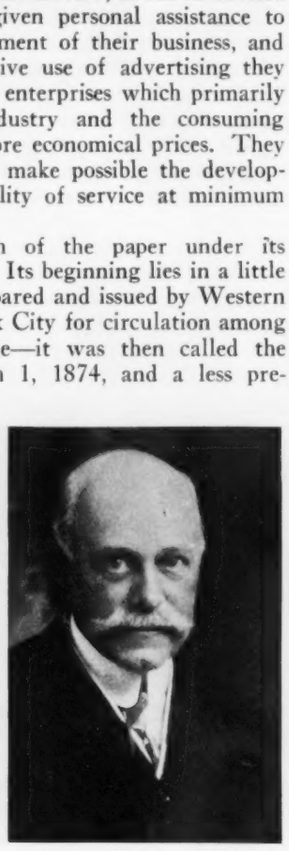
While playing less conspicuous parts in the eyes of the readers, two other groups of men have also done their share to build the paper. These are the circulation and the advertising staffs. The former seek those whose

needs the paper meets. The latter also have played a particularly important rôle. Not only have they done the commercial work which produced an income sufficient to permit adequate editorial service; at the same time and in so doing they have given personal assistance to manufacturers in the development of their business, and by wise counsel in the effective use of advertising they have helped build those great enterprises which primarily furnish to the operating industry and the consuming public better equipment at more economical prices. They have thus done their part to make possible the development of maximum dependability of service at minimum cost to the consumer.

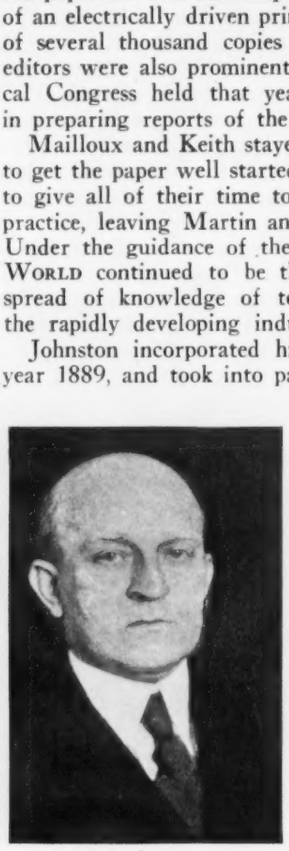
The story of the growth of the paper under its editors is a romance in itself. Its beginning lies in a little four-page telegraph sheet prepared and issued by Western Union operators in New York City for circulation among their fellows. Its first issue—it was then called the *Operator*—was dated March 1, 1874, and a less pretentious start could hardly be imagined. It was not originally intended to have any permanence and was full of local gossip. But some excellent contributions by Thomas A. Edison appealed to the readers, and there was a consequent demand for continuation of material of high quality. The active interest that Edison took in the paper helped to give it vitality.



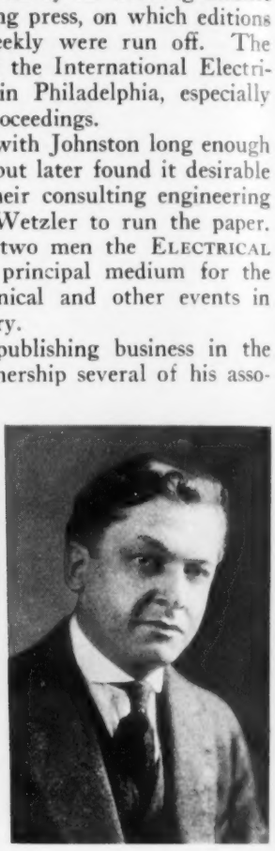
Carl Hering



T. Commerford Martin



A. S. McAllister



F. M. Feiker

In 1876 W. J. Johnston, then a young operator, became the sole owner. For a while he had an uphill fight with the little paper. Again the able contributor helped. C. O. Mailloux, a young French-Canadian engineer, was engaged to prepare some articles on general electrical subjects. These articles were so much appreciated that Johnston saw the advisability of changing the scope of the paper to meet the broader needs of the electrical industry, then in its first stage of growth. This he did with the help of Mailloux and T. Commerford Martin, who had recently joined the staff. Early in 1883 he named it the *Operator and Electrical World,* and soon after it became simply the ELECTRICAL WORLD. On the staff at that time, in addition to Mailloux and Martin, was an experienced mining engineer, Dr. Nathaniel S. Keith, who had shown marked ability along electrical lines and who was instrumental in the starting of the American Institute of Electrical Engineers the next year. A younger member of the staff was Joseph Wetzler.

W. D. Weaver

The ELECTRICAL WORLD was well started and beginning to prosper when, in 1884, the Franklin Institute conducted an electrical exhibition in Philadelphia. Here the paper made a real impression by its working exhibit of an electrically driven printing press, on which editions of several thousand copies weekly were run off. The editors were also prominent at the International Electrical Congress held that year in Philadelphia, especially in preparing reports of the proceedings.

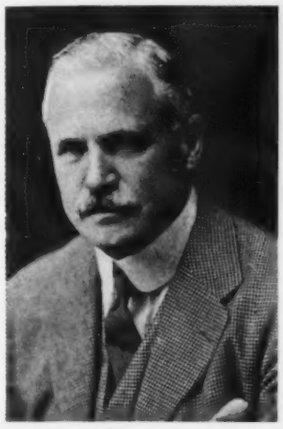
Mailloux and Keith stayed with Johnston long enough to get the paper well started, but later found it desirable to give all of their time to their consulting engineering practice, leaving Martin and Wetzler to run the paper. Under the guidance of these two men the ELECTRICAL WORLD continued to be the principal medium for the spread of knowledge of technical and other events in the rapidly developing industry.

Johnston incorporated his publishing business in the year 1889, and took into partnership several of his associates. But the organization did not work together well, and a break occurred in 1890 which was ultimately to have an influence in the creation and life of the present publication. Martin and Wetzler left the paper to join the *Electrical Engineer,* a rival publication which had been launched in 1882 as a monthly and which was destined later to be a part of the combined paper, the ELECTRICAL WORLD. At that time when Martin and Wetzler joined it, it was made a weekly, and it soon became a serious competitor of ELECTRICAL WORLD.

The immediate successor of Martin and Wetzler was the late Louis Bell, a trained engineer and scientist and a skillful writer. He had as an assistant a young Cornell University graduate, Edward Caldwell, now treasurer of the McGraw-Hill Book Company. Bell was followed by Carl Hering, who established the "Digest of Current Electrical Literature," and Hering was succeeded by a retired naval officer, W. D. Weaver, who had first been engaged to assist in preparing books for publication. In this work Weaver, who had previously written articles for the paper, displayed sound engineering knowledge, keen insight and ability to write, and he was put in charge of the ELECTRICAL WORLD in 1893. At this period, the "early nineties," the paper had as illustrator the now famous artist R. F. Outcault, whose cartoons lent the occasional lighter touch that it is so difficult and

yet so desirable to impart to a technical journal.

Under Weaver's direction many improvements were made in the paper. It was brought down to the present size and the typography changed. An editorial feature of the paper's work under Weaver was the publication of serials of fundamental subjects, afterward issued in book form. For example, A. E. Wiener contributed a series of "Practical Notes on Dynamo Calculation," Dr. Bell one on "Electric Power Transmission," Professors Houston and Kennelly one on "Electro-Dynamic Machinery," and Kempster Miller one on "American Telephone Practice." Weaver also encouraged alternating-current power transmission, as did his predecessor, Dr. Bell.



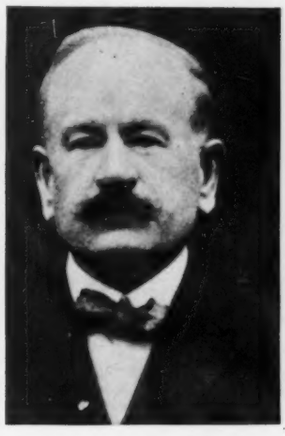
J. M. Wakeman

service to the industry by purchasing the two papers and combining them to produce one really great electrical publication. It was his ambition to furnish to the electrical industry, at this time of most rapid growth, a weekly publication which would render the greatest possible measure of service.

He purchased the papers and consolidated them, first under the name ELECTRICAL WORLD AND ELECTRICAL ENGINEER and later as the ELECTRICAL WORLD AND ENGINEER. There was naturally an entire rearrangement of the staff and also of the business. With three publishing properties, the ELECTRICAL WORLD AND ENGINEER, the *Street Railway Journal* and the *American Electrician*, the business had grown to such proportions that Mr.

N. S. Keith

J. E. Woodbridge



C. O. Mailloux

W. H. Onken, Jr.

Weaver had made a good start as editor of the ELECTRICAL WORLD and was building up a reputation for usefulness for the paper when, early in 1896, Mr. McGraw, who was then in the publishing business with the *Street Railway Journal* as his sole publication, selected him as editor for a new electrical periodical for practical electricians which he purposed founding. Mr. McGraw had bought a small Chicago monthly, *Electrical Industry*, as a basis for this. The idea appealed to Weaver, and he left Johnston after three years as editor of the ELECTRICAL WORLD. For the new paper the name *American Electrician* was selected.

After Weaver's departure the editorial department of the ELECTRICAL WORLD underwent a series of changes while Johnston was trying out men to serve as successor to Weaver. Among those added to the staff were Charles Tripler Child, a brilliant and highly educated Southerner, who remained two years, and J. E. Woodbridge, a technical graduate of all-round experience, who contributed notable articles on water-power development.

By 1898 the competition between the ELECTRICAL WORLD and the *Electrical Engineer* had become so serious as to be recognized as more or less detrimental to the industry because the service of both was being rapidly impaired. Mr. McGraw, who had become interested in the electrical industry as publisher of the *Street Railway Journal* (later the *Electric Railway Journal*) and the *American Electrician*, saw that he could perform a real

McGraw formed the McGraw Publishing Company and became its president. J. M. Wakeman, who joined the company at that time, was made vice-president.

At the time of the consolidation of the ELECTRICAL WORLD with the *Electrical Engineer* the electrical industry was expanding at an astonishing rate. As never before, a strong electrical paper was needed to get behind promising developments. With Wakeman in charge of the business of the paper and Martin and Weaver as chief editors, it settled down to a long period of consistent vigorous activity. Mr. McGraw increased the number of pages in each issue by a third and improved the typographical appearance. He authorized the editors to spend liberally in making the paper a vital part of the electrical industry. In carrying out this commission they did not depend solely on their own knowledge and experience, but drafted the services of Dr. A. E. Kennelly, Dr. Louis Bell and many other able technicians and writers to assist them.

Martin and Weaver made a good team. The former was a prolific writer and the "contact man," who ably represented the paper in industrial activities. The latter was the engineer, scientist and scholar, the confidant of the industry's leaders and the adviser of the rising electrical generation.

From 1899 to 1906 Mr. McGraw was thus publishing two electrical papers. The ELECTRICAL WORLD AND ENGINEER was for the engineers and central-station operators, the *American Electrician* for the "men down the

line," the rank and file of the electrical industrial army, that is, the electricians. Under his management the two papers were strikingly successful. In spite of that fact, however, administrative difficulties developed in publishing two papers in the same field, even though their editorial appeals were different. It was decided therefore to combine the *American Electrician* and the ELECTRICAL WORLD AND ENGINEER in 1906, retaining the name ELECTRICAL WORLD for the consolidated paper. This consolidation brought into the picture another man who was destined to play an important part in the paper's development. In 1900 W. H. Onken, Jr., a former newspaper man, trained on the New York *Evening Post* and with an electrical engineering education, had been added to the staff of the *American Electrician*. When this paper ceased its separate existence and became a part of the ELECTRICAL WORLD, Onken was made managing editor of the latter.

Soon after the consolidation the ELECTRICAL WORLD concentrated its energy largely on the outstanding technical problems and developments of the time. Water-power development, transmission of electricity to long distances, interconnection of power systems and the widespread and increasingly popular use of electrical energy were conspicuous among these. Changes occurred from time to time in the staff. Martin, whose death was announced last spring, left in 1909 to become secretary of the N. E. L. A., in which association the paper has

The "Electrical World's" family tree

On one side the *Operator*, then the *Operator and Electrical World*, then the ELECTRICAL WORLD; on the other the *Electrician*, then the *Electrical Engineer*. These two combined to form the ELECTRICAL WORLD AND ELECTRICAL ENGINEER, later the ELECTRICAL WORLD AND ENGINEER. To this was added *American Electrician*, to form the present ELECTRICAL WORLD.

always been actively interested. Weaver retired three years later because of ill health, but continued to devote himself to literary pursuits till his death in 1919. With Onken as managing editor, the editorial direction was carried on at first by Dr. A. S. McAllister and F. F. Fowle (co-editor with McAllister for one year). On McAllister's retirement in 1915 he was succeeded by F. M. Feiker, now one of the directing heads of the Society for Electrical Development, and two years later Onken became editor.

McAllister and Fowle were both engineers of marked mathematical ability. They contributed much to the scientific character of the paper, which had by then become not only a journal of the electrical industry in America but the leading electrical engineering paper, with a world-wide circulation and influence.

When McAllister retired the electrical field was undergoing another marked change. Up to that time the problems of the industry had principally concerned laying a sound scientific and technical foundation for electrical development. This had now been done, with the ELECTRICAL WORLD playing a really vital part. With the solving of many engineering problems, the approach toward standardization of engineering practice and the adoption of the principle of regulation of public utilities by the various states, however, came the necessity for greater consideration of the economic problems of the industry as well as continuation of adequate treatment of the technical ones. During Feiker's administration the paper expanded still further to meet these new needs. Commercial development was one of the outstanding points to which the ELECTRICAL WORLD then gave greater consideration.

At this time, also, the Research Department was started, with Professor Vladimir Karapetoff as its director and editor. Professor Karapetoff also became a regular contributor to the editorial columns. In this he joined Dr. Louis Bell, who had always remained a consultant to the editorial staff and was a most constructive and delightful editorial writer until the very week of his death; Dr. A. E. Kennelly, one of the oldest contributors to the paper and the master not only of his subject matter but of an agreeable and graphic style, and Dr. J. B. Whitehead, whose contributions particularly on high-voltage phenomena and insulation problems are a noteworthy part of the editorial service of the paper. For it has been the constant policy of the editors to enlist the services of those most able to assist in formulation of constructive editorial thought. These men and others like them, eminent as inventors, engineers, designers, executives and educators, have in turn always welcomed the opportunity to serve and to help build the industry with which they are professionally connected and in whose successful advancement they are vitally interested.

The Present Editorial Staff

W. H. Onken, Jr., became editor just at the time that America entered the war and when the problems of the industry were becoming even more numerous and complex. Onken has traveled in nearly every district of the United States and Canada and much of Europe in the interests of the paper; there is hardly an electric light and power company of any size whose history, chief officers and territory he does not know, and his wide acquaintance, excellent memory, analytical keenness and ability as a writer gave him special fitness as the ranking editor of the paper. The ELECTRICAL WORLD at the time of his appointment had to be shaped to handle, in addition to questions of engineering, problems of finance, of markets, of rates, of legislation, of uniform accounts, of public policy, of unified operation and bulk production, of interchange of energy, of statistics, of industrial applications, of co-ordination between the various branches of the industry, and of principles of merchandising in the sale of electricity and of apparatus utilizing that electricity. One of the most important accomplishments or services of the ELECTRICAL WORLD during the war and just after its close was in connection with the formulation of policies and the education of the industry and the public to favor the enactment of the federal water-power act, which has made possible the great development of water power on navigable streams now going on.

The increased interest in the application of electricity to industry brought to the staff D. H. Braymer, previously editor of the *Southern Electrician* and now editor of the *Industrial Engineer*, a McGraw-Hill paper published in Chicago. Mr. Braymer became managing editor and subsequently was co-editor for about one year. In 1922 H. V. Bozell, former editor of the *Electric Railway Journal* and previously a professor of electrical engineering at Yale, was appointed co-editor with Onken, these two being the present editors of the paper.

But editors in chief are not alone the ones who actually make the editorial service of a paper. The ELECTRICAL WORLD has always been fortunate to be able to attract men of ability to its staff as editorial associates. It is not possible to give credit to all who have thus served, many of whom now hold important positions in the industry. To the present staff, however, full credit must be given for the share each has played in making the present ELECTRICAL WORLD. This staff includes L. W. W. Morrow, associate editor and acting managing editor; Earl E. Whitehorne, chief commercial editor; Allen M. Perry, Western editor at Chicago, formerly engineering editor at New York; Howard S. Knowlton, New England editor at Boston; Robert M. Davis, statistical editor; Theodore P. Kindig, central station commercial editor; Walter C. Heston, Pacific Coast editor at San Francisco; Frank C. Wells, news editor; R. L. Shepherd, assistant engineering editor; Eustace C. Soares, trade and markets editor; S. S. Boies, "Construction News" editor; E. M. Glennon, assistant statistical and financial editor; H. C. Anderson, assistant editor at Chicago. With this staff of associates of experience and ability in engineering, commercial and correlated lines the editors have made it possible for the ELECTRICAL WORLD to furnish the electrical industry with a comprehensive service never before approached.

The expansion and development of the electrical industry, however, made it evident some years ago that the ELECTRICAL WORLD could not give adequate attention in its own columns to all the separate groups of increasing importance that needed individual or special service. With the ELECTRICAL WORLD as the parent paper, the publisher has therefore gathered into its family certain specialized papers—the *Industrial Engineer*, for electrical men in industrial plants; the *Journal of Electricity*, the sectional electrical paper for the Pacific Coast; *Electrical Merchandising*, an appliance paper for the electrical merchant, and *Electric Retailing*, an appliance paper for the non-electrical merchant who sells electrical appliances. Each of these papers has thus its individual constituency. They leave the ELECTICAL WORLD free to devote itself to general and major problems and the news of the entire electrical field.

Fifty Years of "Electrical World"

How pioneers were handicapped by lack of tools—Comparisons with present-day conditions—Suggested revisions of some older electromagnetic laws heretofore taken for granted

By Carl Hering
Consulting Engineer, Philadelphia

THE present generation of younger electrical engineers, who have been taught what is known today about electricity and have well-equipped laboratories, have no conception of the difficulties encountered by those who started in the early days, nearly fifty years ago. Let them, for instance, picture to themselves the difficulties of Stanley in developing the transformer for Mr. Westinghouse less than forty years ago from the old Ruhmkorff coil, without any instruments for measuring alternating currents other than the old form of torsion electrodynamometer, and without any knowledge of such things as hysteresis or of phase differences. Yet he did it The lack of measuring instruments for even direct currents, other than the tangent galvanometer, was a very serious handicap. It was then almost like building a house or machine or bridge without such tools as a foot rule, square or a scale. Even many of the units, names and terms did not exist then or were not clearly defined and understood. The writer, as a young man, lost a good situation because his employer was sure that the conversion factors he had calculated between mechanical and electrical units were quite wrong, though they were the same values as those used everywhere today. The only "laws" for designing dynamos in those days were to test the other fellow's machine and try to make a better one and paint it a different color.

In the very early days the only use made of electricity was for telegraphy and electroplating. Edward Weston built dynamos for electroplating in the early '70s. In this country there were two exhibits at the Centennial Exposition in Philadelphia in 1876 that started interest in the application of electricity, the telephone of Bell and two arc lamps in the French exhibit, each of which, however, required a separate Gramme machine. True electrical engineering may be said to have begun in the late '70s, when Edison perfected the incandescent lamp and the system of distributing it, and when Brush, West, Thomson and Houston perfected the operation of arc lamps in series, and when the telephone came into public use.

The life of the ELECTRICAL WORLD and its predecessor covered the whole of this long period of about fifty years, and the records in it form a history of electrical development during what may well be termed the "greatest fifty years of man." Though in its early years the ELECTRICAL WORLD gave less attention to the rapid technical developments than its chief and younger competitor, it was a wide-awake, enterprising and up-to-date journal. As an illustration, when in 1891 there was exhibited in Germany the first practical installation of a transmission of power of about 100 hp. over about 100 miles by three-phase currents, the proprietor, W. J. Johnston, sent the writer to Germany to cable back news about it and gather first-hand information for articles And when the progress of electrical engineering about that time became so rapid that no one journal could possibly keep the country informed, the writer, who was then the editor, suggested to Mr. Johnston that he devote a section of his paper to a weekly digest of current electrical literature here and abroad. It was started a few weeks after it was proposed, was conducted by the writer for eleven years and has been a feature of the ELECTRICAL WORLD ever since.

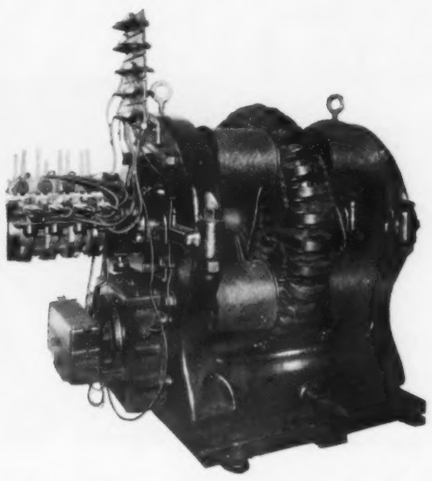
At the first electrical exhibition held in this country, that conducted by the Franklin Institute in Philadelphia in 1884, the ELECTRICAL WORLD, then only a year old under that title, was very prominent, and its editor, the versatile T. C. Martin, was continually "on the job." From that time on it expanded and became more generally known.

As an incident showing its enterprise in those early days, it sent its editor and its artist to Niagara Falls to "write up" the constructing work on the long tunnel for the first large power plant. The authorities, for some unknown reason, forbade taking photographs or making sketches and therefore refused to let the artist enter the tunnel. The editor, however, took a mental picture of it with estimated dimensions and transferred it later to the artist's mind, and the latter then drew the first and only picture of the boring of this tunnel which was published, much to the surprise of the tunnel authorities. It was even better than a photograph.

The history of the development of electrical engineering is well recorded, but such a milestone as the one denoting fifty years of progress gives an opportunity to call the attention of the younger generation to some comparisons and some less well-known facts which show a few of the difficulties under which the pioneers of the early days had to work.

In the early '80s there was no college in this country where one could take a course in electrical engineering; the writer at that time had to go to Europe for such a course and found only one, in Germany, and that very primitive. The professor filled the blackboard with the algebraic relations of the elaborate Clausius theory of the

"Mather" 250-Light, 110-Volt Shunt-Wound Generator of 1885



A 125-Light Multiple Circuit Series Arc Lighting Dynamo Built by the General Electric Company in 1898

dynamo, which were of no use whatever afterward to the practical designer.

In the "testing" of the dynamos at the electrical exhibition at Vienna in 1883, at which the writer took a prominent part, one of the machines, a small alternator by Klemenco, the first of the kind, having no moving wire, was found to take 5 hp. when fully loaded and 15 hp., or three times as much, on open circuit. The "higher ups" were baffled. Its wireless armature was not laminated.

At the Philadelphia exhibition in 1884 we had to resort to a calorimeter consisting of a coil in a barrel of water in order to measure the then huge current of a generator giving 5,000 amp. at 5 volts.

The first intention of the promoters of the Niagara Falls power plant with the long tunnel was to make it a "land-booming scheme." The profits were to be made by buying cheap land, building the tunnel to and under that land and then selling building lots to power users with the privilege to use the tunnel as the tailrace for their water power. But when in 1891 it was shown for the first time that electric power could be transmitted cheaply to a distance by three-phase alternating currents, the plans of the original promoters were completely upset and their land-booming scheme failed as such.

When in 1892 the writer prophesied at a meeting in Buffalo that that city would before many years get its electrical power from Niagara Falls as three-phase alternating current, he was ridiculed by one of the leading experts of one of the largest electrical manufacturers, who had failed to make the polyphase motor a success.

Duing those early days, when the commutator gave most trouble, great efforts were made by many to devise a direct-current generator without a commutator and not of the low-voltage, unipolar type. Persistent failures during many years led to the belief, which probably was taught in some colleges as a fact, that it was theoretically impossible, yet it has recently been shown to be possible.

Progress during these fifty years has been so rapid that we have lost sight of the fact that some of our older laws of electricity and magnetism were formulated fifty or more years ago, when the leaders did not have the facilities we have today. Hence the time has now come when we ought to re-examine those laws to see whether they are really universal or only special-case laws, for, if the latter, there may be useful fields of progress opened up to us which have been closed by assuming the laws to be universal; that is, without exceptions. Some such exceptions have recently been brought to light, and since we have learned that a current consists of moving electrons, some of our older laws need revision.

The Technical Press and What It Does

The varied functions on which its indispensability is securely built—The industrial journal promotes, above all, "that co-ordination of effort which means progress in its field"

By Guy Eastman Tripp

Chairman of the Board
Westinghouse Electric & Manufacturing Company

IN THE development of any industry there must not only be workers but there must be some agency or agencies which will co-ordinate their work. In the electrical field the technical school and the professional societies are important factors in this work of co-ordination, but equally important and, in fact, supplying both of these factors with much of their power, is the technical magazine. To the technical magazine, however, is not always accorded the honor due it, and it is well, on this fiftieth anniversary of the ELECTRICAL WORLD as a great representative of the technical press, for its readers to remind themselves that they cannot get along without it.

It provides a vast reservoir of knowledge from which every one in the industry draws, directly or indirectly. It presents a vivid picture of the current state of the industry, showing what is being done and who is doing it. It stimulates research by indicating the unfilled needs of the industry and by dropping hints of valuable significance to many workers. It saves a great deal of lost motion by mapping out ground already explored.

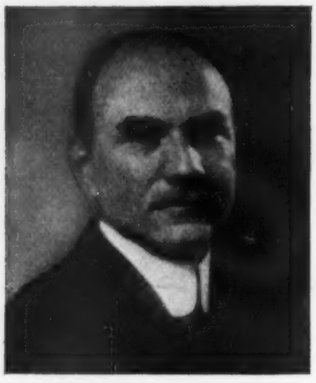
Its editors are the industry's most reliable guides and advisers. It provides a public forum where ideas can be set forth, criticised, upheld or shown to be fallacious. It protects the industry from the crank and does what it can to protect the crank from himself. It leads the industry always toward better things, higher efficiencies and economies.

And it does many other things—too many, indeed, for any one to catalog. But perhaps its most important function is the bringing about of that co-ordination of effort which means progress.

The electrical industry has always been fortunate in its technical magazines. Even before the industry, as we know it, came into existence, when it was a mere embryo—an affair of batteries, crude dynamos and cruder arc lamps—there was an electrical magazine ready to grow *pari passu* with the giant that was soon to be. Today the electrical press of America represents the highest standard of technical journalism, and to those who have made it what it is and have labored in order that we of the industry itself might be saved from expending many an unnecessary hour or dollar, electrical development the world over owes a very large debt.

Eminent Professors of Electrical Engineering

Some of the instructors who have trained and inspired thousands of the industry's leaders and most promising men



Dugald C. Jackson

Harold Pender

Comfort A. Adams

Michael I. Pupin

Harris J. Ryan

Arthur E. Kennelly

W. A. Anthony*

E. L.Nichols

Henry A. Rowland*

Frederick Bedell

*Deceased

The Field of a Technical Journal

The "Electrical World" in its relation to the science and art of electrical engineering during the last fifty years—How it has kept pace with the constantly accelerated march of invention and adaptation

By A. E. Kennelly

Professor of Electrical Engineering, Harvard University and Massachusetts Institute of Technology

THE last half century has been essentially the great period of electrical engineering development, and the ELECTRICAL WORLD, including its predecessors and tributaries the *Operator* and the *Electrical Engineer,* has been a partner and participator in that development.

In 1874 electric telegraphy was in extensive use, both by land wires and submarine cables; so that telegraph engineering was the only type of electrical engineering known. Today we have large electric transmission and distribution systems for the widespread delivery of light and power. We have extensive electric traction and propulsion systems, electric heating and furnaces on a large scale, wire telephony and radio communication. In every phase of this great advance the ELECTRICAL WORLD has been a witness and speaker.

In 1874 Brush and Thomson were experimenting on arc lamps, while Edison was inventing improvements in telegraphy and commencing his studies on the incandescent lamp. The *Operator* addressed itself to those engaged in telegraphy, but it reported from time to time the new electrical discoveries and inventions.

In 1875 the Bell telephone was born in Boston and commenced to reveal its capabilities in an experimental way. A moving-picture hall now occupies the space in which Bell and Watson worked on the new instrument. The *Operator* followed up the various announcements as they were made known.

It was the Centennial Exhibition at Philadelphia in 1876 that brought the telephone into prominent notice. Sir William Preece took a pair of hand receivers back to England with him. Up to that time the telephone was regarded as a toy, but in 1877 it began to come into commercial use.

Edison's early incandescent lamps in 1878 and 1879 attracted much attention in electrical circles, as reflected in the *Operator's* pages. Edison's remarkable intuition led him to seek for high-resistance incandescent lamps for operation in parallel, together with a low-resistance dynamo for constant-potential delivery. It was the common belief in those days that the best dynamo would have an internal resistance equal to the total resistance of the load and would therefore be limited to an electrical efficiency of only 50 per cent. Edison saw that while the maximum output of a dynamo would always be theoretically obtainable under such conditions, yet a low-resistance dynamo would be able to operate at full load when the load resistance was perhaps twenty times the armature resistance, and with an efficiency of 95 per cent.

About the same date the Brush, Weston and Thomson-Houston arc-lighting systems were coming into use. Electric lighting of towns and highways began to be adopted, and by 1880 the prospect was bright for the advent of electric incandescent lighting of buildings and their interiors. The steamship *Columbia,* which started in May, 1880, on a voyage from New York to San Francisco, was the first to have an incandescent lighting installation.

Hitherto there had been an art as well as a science of electric telegraphy, but there had been only a restricted science of electric lighting, followed by an inventive period. The art of electric lighting began to be formed in the early '80s. The *Operator* found itself unable to cope with the new development and became the *Operator and Electrical World.* Soon afterward the ELECTRICAL WORLD continued to follow the new field alone, leaving the *Operator* to maintain its service in the art and science of telegraphy.

The ELECTRICAL WORLD started under its own name at a time when invention in the applications of electricity was very active both in Europe and in America. The rate of development of these applications became correspondingly rapid. Edison's laboratory at Menlo Park became an electrical Mecca—so much so that the Pennsylvania Railroad Company at one time had to run special trains between New York and Menlo Park in order to accommodate the crowds of visitors when incandescent lamps were first operated in and on the laboratory buildings. The early volumes of the ELECTRICAL WORLD bear ample testimony to the rapid growth of the electric lighting art.

The Pearl Street Station

The first central lighting station in a city of any size was the Pearl Street station in the downtown district of New York City, near to the Brooklyn suspension bridge. Its opening date was September 4, 1882, a memorable signpost in the American central-station calendar. A bronze tablet erected at 255 Pearl Street in 1917 now indicates the site of this first Edison central station of New York City.

The American Institute of Electrical Engineers was founded in New York in 1884, with Norvin Green of the Western Union Telegraph Company as its first president. Up to that time there had been telegraph engineers, but electrical engineering as a profession had scarcely become recognized. The same was true in other parts of the world. The Institution of Electrical Engineers of Great Britain was founded originally as the Society of Telegraph Engineers, in 1872, at London. It changed its title to the Society of Telegraph Engineers and Electricians in 1881 and finally assumed its present title in 1889.

An examination of the pages of the ELECTRICAL WORLD during the early '80s reveals the absence of electrical engineering instruction in the universities and technical colleges, although civil engineering had been recognized in several colleges for some time Of course, the fundamental sciences of mathematics, physics and chemistry were taught in all of the important colleges all the world over; but applied electricity and applied magnetism were not taught specifically prior to the advent of the telephone and incandescent lamp, although some instruction had been given in physics before that time, directed to telegraphic applications of electricity. Applied electricity and electrical engineering became recognized courses of instruction soon after the opening of the central-station industry. At the present time at least half a dozen courses in different branches of engineering are offered in the technical colleges, and in all of these applied electricity takes part. The ELECTRICAL WORLD has followed this educational movement from the start and has stimulated progress along this direction in various ways. In fact, the close and growing association between electrical industries and electrical engineering education has been distinctly aided and influenced in this country by the ELECTRICAL WORLD.

Early Units for Measurement

In order to buy and sell electrical energy for motors and light, as produced by incandescent and arc lamps, it was necessary to develop both scientific and industrial units for the measurement of energy and light. These units had to be agreed upon by physicists and by electrical engineers, internationally as well as nationally, because if they varied from country to country, the greatest confusion might result. The industrial unit of energy adopted was the watt-hour, ordinarily expressed in thousands, or kilowatt-hours. The watt was adopted as the name of the unit of power at the International Electrical Congress of Paris in 1889, of which the ELECTRICAL WORLD gave a good account. A slightly improved definition and value were again adopted for the international watt at the Electrical Congress of Chicago in 1893. Since that date all electric lighting and power bills have been made out in terms of the international watt-hour or kilowatt-hour all over the world. The watt and watt-hour, although defined electrically from the international metric system, are actually also units of power and energy in other branches of engineering.

Fifty years ago the units of measure in lighting and illumination were very crude and unsatisfactory. The standard candle was the luminous intensity of an actual candle burning at a specified rate in grains per minute. These candles, even when constructed as nearly alike as was then practicable, differed markedly in their luminous intensity. After much experimental effort in various countries, the Pentane lamp was developed in England, the Carcel and the Violle lamps in France and the Hefner Alteneck in Germany. Finally the incandescent lamp itself, suitably aged and selected, was agreed upon as superior to any existing fuel-burning standard, and by mutual agreement among the various national standard laboratories of the world groups of selected incandescent lamps, operated at carefully measured voltages, now maintain the standard international candle with remarkable uniformity, aided by occasional intercomparisons. This wonderful story has been duly told in the ELECTRICAL WORLD from time to time

In the metering of all the electric energy from supply mains to consumers, in terms of the kilowatt-hour, the Thomson electromagnetic motor meter, which received the international award at the Paris Exposition of 1900, has become the principal device to be employed. That is still another story recorded in the ELECTRICAL WORLD.

Following in the wake of the electric lighting industry, the industries of electric traction, electric welding, electric storage batteries, electric hoists and elevators, electric motor propulsion of ships and high-tension power transmission have followed steadily. In the cases of electric street-car traction and electric railroading the industries have grown to such proportions that the ELECTRICAL WORLD could not keep pace with them while maintaining its regular duties, so that separate technical journals have grown up to attend to their needs.

Scope of a Technical Paper

When looking through a series of volumes of the ELECTRICAL WORLD covering a period of several decades one is struck with the vast amount of historical material they contain reflecting on electrical engineering development. There are articles presenting purely scientific aspects of the subject, articles on the trend of electrical sciences, on the meetings of engineers, reports of engineering papers, the history of established electrical industries, references to electrotechnical literature in this and other countries, legal decisions in electrical industries, patents in electrical fields, accounts of electrical progress and accomplishments, news of the industry, descriptions of notable engineering personalities, rulings of industrial commissions, editorials, news of construction, trade activities and reports concerning electrical business conditions. The numerous advertisements, often excellently illustrated, have not only commercial value but also great historical significance in relation to the art of engineering. It must also be remembered that any technical journal has not only to supply desirable information to its readers, but must also produce the printed numbers on schedule time. News must be fresh to be acceptable, and nothing is more inexorable than the printing office calendar.

In order properly to estimate the importance of technical journals to the industries they serve, one has only to imagine what might happen in the case of their complete suppression. How difficult it would become to obtain adequate information as to the progress, accomplishments, history, service, personalities and prospects in the industry. This uncertainty would be likely to reflect itself in all of the activities concerned. Definiteness of purpose and of statement would diminish, while indecision might be expected to supervene everywhere.

According to the statistics printed for the end of 1922, there were in that year forty-six billion kilowatt-hours of energy generated collectively by all of the American electric light, power and railroad stations, which represents an average continuous output of approximately 50 watts for each head of population at that time. Each individual may thus be regarded as carrying about a 50-watt lamp constantly operated by the central stations of the country. The ELECTRICAL WORLD has been the companion of this great industry and has witnessed its early stages of growth. It has seen nearly ten millions of residences wired for electric equipment. Some three hundred thousand central station employees serve some thirteen million of customers at the present time, or one employee to forty or more customers. Thus the advantages of the electric switch have been opened to about half of the dwellings in the country.

The last fifty years have seen the domestication of electricity for lighting, heating, power, propulsion and telephone communication, both with and without wires. We

are still uninformed as to the fundamental nature of electricity, but we have recently learned to think in terms of the electron, or natural unit of negative electricity. Fifty years ago electricity had already destroyed the sense of isolation in remote districts visited by electric telegraph wires. At the present time electricity, by radio dissemination of the voice, has broken down the sense of isolation in all parts of the country, whether within touch of telegraph wires or not. The building up, piecemeal, of this wonderful story of the banishment of isolation from the world is spelled out year by year in the ELECTRICAL WORLD.

What the next fifty years may have in store for the world of electricity and electric distribution it would be a bold prophet who should undertake to declare; but it is to be hoped that the ELECTRICAL WORLD will continue, year by year, to record, suggest and stimulate in the future, as it has done so well in the past.

Fifty Years in Retrospect

How the scope of the technical paper has enlarged in keeping with the growth of the industry — Value of courageous editorial opinion and of a comprehensive news service

By Frank F. Fowle

Consulting Engineer, Chicago

TO LOOK back a half century in the electrical industry is to visualize its crude beginnings, even before electricity (save for the telegraph) had become the servant of man. That was the day of the pioneers, Edison, Bell, Thomson, Brush, Stanley and their early followers, who were presently to give the world their epoch-making discoveries and crown the age of invention with the most brilliant era in history. So short is this marvelous epoch that many of its venerated pioneers are still happily with us. But in contrast with the ages it is scarcely a passing beam of sunshine flitting across the field of time.

In this brief span has sprung up an industry which bids fair to outshadow all the others. For not only is the electrical industry a young giant in its own right, but it pervades all other industries, not excepting the greatest—agriculture, transportation, mining and manufacturing. It is the servant and tool of all. Even more, in future, it promises to become the universal substructure of our complex civilization, ministering to man's every need and want, relieving him of arduous labor and materially increasing his leisure for the pursuit of culture and spiritual development.

Now comes the oldest journal of electrical engineering in America to commemorate its half-century mark, to pause in retrospect over fifty years of service and to take counsel for the future. In humble spirit we may properly ask, what of it? What does it matter whether an industrial class journal exists or not, and of what import to the industry are the ethical standards and the editorial policies under which it is published? These are fundamental questions worth pondering briefly.

Fifty years ago the electrical pioneers were presently to match the achievements of Watt, Stephenson and Fulton with steam, to give the world the incandescent lamp, the telephone, the arc lamp, the dynamo and the motor. Where pioneers blazed the trail there were none to show the way, but followers came close and fast. The master minds of the new industry were those who were developing its technique. Technical advancement was the center of interest, and this fact explains the character of the electrical journals of that day. Both the science and the art made rapid progress; a new field of engineering was coming forward and a new type of education was soon demanded.

During the two first decades the class journals of this new industry were devoted essentially to technical progress and engineering and largely to that alone. There was little need or occasion for aught else until the passing of the old century marked the approaching end of the competitive era in public service and the ushering in of the period of corporate consolidation. The new tendency became evident in manufacturing as well as among the operators. Thus began a new epoch which bore resemblance in several particulars to the earlier period of railroad consolidation, when the pioneer roads, usually or frequently of limited mileage and territory, were consolidated into through systems under one management and ownership, with marked improvement in service and facilities.

New problems in electrical journalism were presented by this new aspect of the industry. The operating companies entered a period of phenomenally rapid development, and necessarily manufacture kept pace. Engineering was gradually thrust from its earlier prominence to make room for problems of organization, plant management, rate making, public regulation of rates and service, commercial methods and the like. Today the industry is notable for the great properties and remarkable organizations which have been created by such builders as Insull, Vail, Coffin and Westinghouse. These organizations now represent billions of invested capital, and each year their aggregate needs for fresh capital to keep pace with public demands for service present a striking demonstration of the fundamental importance and stability of the industry. The holding of public confidence in their credit and their management is without doubt the most important task today in the whole industry and calls for managerial ability and operative skill of the highest order.

Better to Hold Wrong Views than None

It needs little imagination to grasp the fact that fifty years of marvelous evolution and development in electrical science and the electrical arts, taken with the equally marvelous corporate development, have compelled a corresponding evolution in electrical journalism. Even within the memory of those whose service covers but half this span there has been a notable change in the character of technical journalism in our industry. Three to four decades ago the ELECTRICAL WORLD was devoted primarily to the field of electrical engineering, but today its field is the whole electrical industry. Where once the field of technical progress formed the chief interest of its audience, today that audience is vastly larger and diversified through every branch of a highly intricate and functionally organized industry, ranging from monster generating stations to publicity methods, from corporate finance to household utilities, from major organization problems to wiring devices.

The changing character and composition of the ELECTRICAL WORLD to keep pace with the rapid evolution of the industry can be traced through its whole existence. Its news value to the men of the industry has naturally grown

in proportion and is today one of its most valuable features. In fact, this one feature alone gives it the character of an indispensable utility. But electrical journalism in its best sense does not comprise the mere publication of news, or chronicles of advances in the art, or discourses on the operation of public utilities. Class journalism which stoops to fatuous praise and self-admiration never commands respect and rarely wields any real influence, but the journal which expresses capable and independent editorial opinions on the events of the day and the current problems of the industry will always command attention and frequently mold the opinions of its readers. In fact, experienced editors have been known to say that it is better to be on the wrong side, regrettable as that might be, than to have no opinion at all.

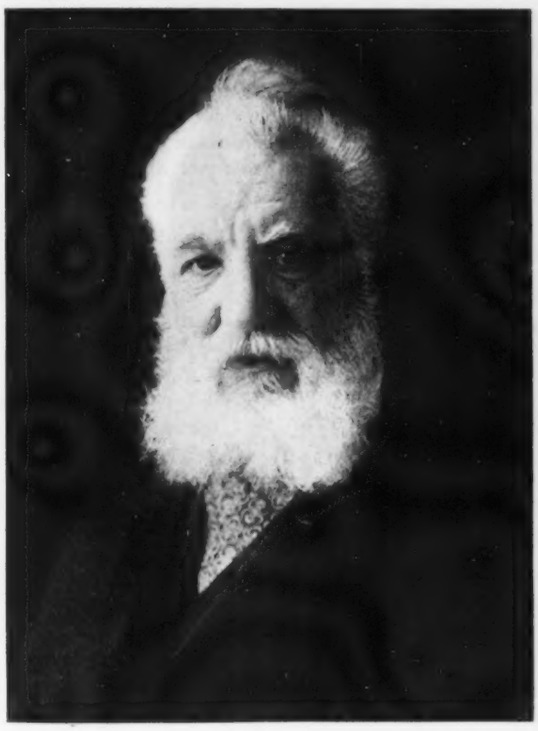
Very probably there is no more outstanding feature of the ELECTRICAL WORLD taken through its entire half century of service than its weekly editorial opinions and comments on events, on technical progress and on problems of the industry. These editorials have come from the pens not only of the editors but almost equally from eminent engineers and leaders in the industry. In this feature it is probably safe to say, without favor or prejudice, that the ELECTRICAL WORLD has never on the whole been excelled by any other journal in the electrical industry and has always been one of the recognized leaders.

If the next fifty years of electrical development prove as marvelous as the last fifty, obviously the state of mankind should be immensely benefited. The chief criticism of man's progress during the so-called age of invention, of which the last fifty years are admittedly the most notable, lays emphasis on the disparity between his advancement in the material sense and his spiritual progress. There are signs today that this disparity is being taken more seriously, that men are more generally recognizing that mere material progress for its own sake does not make for greater contentment and happiness, but in the end for less. It will then be true in more potent measure than ever before that future progress in electrical science and the electrical arts must be used unselfishly and intelligently for the greatest good of mankind. If we fail in this, we can blame only ourselves if the trend of civilization is toward the Tower of Babel. Upon the engineering industries and upon engineers as men will lie an increasing measure of responsibility for wisely and safely guiding the new forces of civilization. In this task they can be aided and inspired by that type of class journalism which fearlessly puts principle above expediency and the public welfare above individual gain or ambition. Such aid and inspiration is the future opportunity and privilege of the journal which has completed a half century of service with such distinction and devotion to high principle.

Birthplace of the Electric Incandescent Lamp, Phonograph and Carbon Telephone Transmitter

The Edison Laboratory at Menlo Park, N. J., erected in 1876 by Samuel Edison, father of Thomas Alva Edison; abandoned in 1883 and destroyed during windstorm in 1913.

"Shrine of the mighty, can it be
That this is all remains of thee?"



Alexander Graham Bell

Theodore N. Vail

The twin stars of the telephone industry who founded and brought to fruition the magnificent and incomparable American telephone system

Triumph of the Telephone

From a single pair of instruments connected by a few yards of wire to a system requiring thirty-four million miles of conductor is the record of forty-eight years

By J. J. Carty

Vice-President American Telephone & Telegraph Company

THE year 1874, which witnessed the appearance of the first number of the *Operator*, progenitor of the ELECTRICAL WORLD, also found a young man, twenty-seven years of age, earnestly striving to invent a multiplex harmonic telegraph that would enable several telegraph messages to be transmitted simultaneously over a single wire. This young man was Alexander Graham Bell. During his experiments with the harmonic telegraph Bell had before him continually the vision of transmitting speech electrically; in fact, in the summer of 1874 he made a sketch of a speaking telephone which subsequently became a part of his first patent. It was in that year that he formed the conception of the principle upon which the telephone works. In the following year, 1875, he succeeded in transmitting speech sounds, and then, on March 10, 1876, was transmitted the first recorded sentence: "Mr. Watson, come here; I want you."

Early numbers of the *Operator* contain accounts of the exhibition of Bell's telephone at the Centennial Exposition at Philadelphia in 1876 and of the astonishment and delight of Dom Pedro, Emperor of Brazil, at its performances; of Professor Bell's lectures and demonstrations of his invention at various places, and, soon after, of its practical use in Boston, Providence and New York. But the limitations of this brief review will not permit chronicling the romantic history of the early development of Bell's invention. There can be recorded here only a few of the most noteworthy landmarks which characterize the marvelous growth that has taken place from the two crude instruments at the ends of a single short piece of wire which originally constituted the entire telephone plant of the world to the great public utility employing thirty-four million miles of wire that today plays so important a part in the daily service of the American public.

From the beginning every branch of the telephone business had to be created, but, first of all, the art had

to be developed, and it is with the technical progress of the industry that this review is chiefly concerned. The development of the art has been accompanied by the evolution of the profession of telephone engineering. By means of organized development and research work numberless limitations and difficulties which at every step have threatened to stunt the growth of the business have been overcome. Thousands of scientists and engineers have contributed to this great work of building up the art of telephony.

The telephone receiver has passed through a long period of evolution, each successive step in its development either increasing its talking efficiency, or improving the mechanical features of its design, or producing a type adapted to some special condition of use. The extent of this development is indicated by the fact that the present standard receivers in use in the Bell System alone have been preceded by no less than fifty-six different types, each one of which has at some time been a standard but is now obsolete.

In the beginning the receiver, held in the hand, was also used as a transmitter, but this and subsequent forms of magneto transmitters were not sufficiently powerful to meet the requirements of the growing industry. Various types of variable-contact resistance transmitters invented by Berliner, Edison and others preceded the Blake transmitter, which was extensively used for a long time. It was eventually displaced by the granular-carbon type of transmitter based on a principle invented by Hunnings but rendered practical for the first time in 1890 in the solid-back type of transmitter now universally used. Many improvements over the original design, resulting in increased power, have been made in this form of transmitter. Since the beginning of the business seventy-seven different types of transmitter now obsolete have preceded the present standards.

Rural-line development was first attempted by connecting the stations in series, with the result that the transmission of speech was greatly impaired owing to the presence of the bell windings in the circuit.

The invention of the bridging bell, whereby without in any way interfering with the transmission of speech or causing disturbances upon the line many stations could be attached to one circuit, has made it possible to extend telephone service into rural districts and farmers' homes, even to those remote from towns and villages.

Switchboards, Wire, Cables and Repeaters

From the first commercial switchboard, installed at New Haven, Conn., in January, 1878, having a capacity for eight subscribers' lines, to the present 10,000-line switchboards, there extends a continuous line of improvement, marked by such important developments as the flexible connecting cord, the spring jack, the electromagnetic annunciator, ringing and listening keys, the multiple switchboard and busy test, the bridging principle, the common-battery system, trunking apparatus and methods of many kinds, the private-branch exchange and a multitude of other features.

The development of the manually operated switchboard has been characterized throughout its history by a steady increase in the proportion of the operations that are performed by electromechanical appliances. During later years there has been extensive development of machine-switching systems in which the subscriber, by means of a movable numerical dial attached to his substation set, puts in motion complex automatic mechanism at the central office and directs it so as to obtain the desired connection. The use of machine-switching equipment is being steadily extended in situations particularly adapted for its use.

To meet the requirements of the outside plant there have been developed hard-drawn copper wire, the balanced metallic circuit, transposition systems and the "phantom" principle by means of which it is possible, under suitable conditions, to make a third circuit out of two metallic circuits.

Underground and aërial cables have successively employed as an insulating material gutta percha, rubber, oil, cotton and dry paper. The number of wires in a single cable has been increased by painstaking development work from 100 wires in the year 1888 to 2,424 wires at the present time. This has resulted in decreasing the cost of a mile of circuit in full-size cable to one-tenth the cost that would have obtained had the best type of cable known to the art in 1888 remained in use today.

TABLE I—HOW THE RANGE OF TELEPHONE TRANSMISSION HAS INCREASED

Year	From	To	Length of Circuit, Miles
1876	Boston	Cambridge	2
1880	Boston	Providence	45
1884	Boston	New York	235
1892	New York	Chicago	900
1903	New York	Omaha	1,600
1911	New York	Denver	2,100
1913	New York	Salt Lake City	2,600
1915	New York	San Francisco	3,650
1921	Havana	Catalina Island	5,500

Owing to the improvement and the application of loading coils, based upon the fundamental patent of Pupin, the plant of the Bell System alone has more than a million miles of loaded circuit. The use of quadded cables has permitted the application of the phantom-circuit principle to certain kinds of cable construction.

Advances in long-distance transmission have been achieved, not by the use of any one device, but rather by comprehensive improvements in line, switchboard and all of the numerous instrumentalities employed. Notable among these is the telephone repeater—a complex organization of circuits and apparatus involving numerous scientific advances. The best type of modern telephone repeater now employs, as one of its elements, the improved audion based upon the original invention of De Forest, which has been rendered a practical and stable instrument by the perfection of the vacuum tube.

By the cumulative effect of all of the improvements it is now as feasible for a man in New York to speak to an associate in San Francisco as to any person in his own city. To have obtained by the use of larger wires the same character of service that the repeater and its associated apparatus have made possible would have entailed plant expenditures so huge that the cost of the service over great distances would unquestionably have greatly restricted its commercial availability. The successful use of repeaters in the telephone plant has involved the development of much auxiliary apparatus and the solution of many very difficult problems of balancing the lines and all of the associated apparatus.

Successive steps in increasing the range of toll telephone transmission are indicated in Table I. In 1881, when even a quarter of a mile of cable was employed in the line as part of the circuit, talking from the city to the suburbs was attended with much difficulty. Methods are now known whereby talking would be possible between New York and San Francisco with the wires entirely in cable.

In 1915 speech was transmitted for the first time by radio telephone from Arlington, Va., across the continent

to San Francisco, over the Pacific to the Hawaiian Islands, and across the Atlantic to Paris. In 1923 long telephone messages were successfully sent by transoceanic radio from a telephone station in New York City to a group of scientists and journalists in New Southgate, England.

One of the most interesting developments of radio telephony has been broadcasting, the operation of which is too fresh in the mind of the public to require detailed description. For broadcasting speeches and entertainments there are more than four hundred active broadcasting stations in the United States, and it is estimated that there are more than three million receiving stations.

By combining telephone and telegraph currents with high-frequency currents and employing suitable selective means for segregating and directing the combined currents it has become possible, under suitable conditions, to obtain as many as five simultaneous telephone connections or twenty telegraph circuits over a single pair of wires, thus solving the problem upon which Professor Bell was engaged half a century ago at the time when he invented the telephone.

By special apparatus enabling the speech power of a transmitter to be amplified several hundreds of million times it was, in 1921, made possible for the late President Harding's inaugural address to be heard by more than one hundred thousand people, and in the same year by the same means, in connection with the long lines, the Armistice Day exercises at the burial of the "unknown soldier" were heard by more than one hundred and fifty thousand people in Arlington, Va.; New York and San Francisco. In 1923 President Coolidge's message to Congress was broadcast through six radio stations at Washington, New York, Providence, St. Louis, Kansas City and Dallas, thus enabling the Chief Executive for the first time to address in person millions of citizens within range of these broadcasting stations, which cover two-thirds of the United States in area and four-fifths in population.

There have been mentioned above only a few of the outstanding accomplishments of telephone research which permeates the entire technical portion of the industry, reaching into every nook and cranny where may lie concealed the opportunity for improvement and economy. Every reduction in cost has accrued to the benefit of the subscriber and has helped to put the telephone within reach not only of his hand but also of his pocketbook. Telephone research, originated by Alexander Graham Bell, has been constantly expanded until now the technical staff devoted to development and research in the laboratories founded by Bell numbers three thousand.

Table II gives statistical information as to the growth of the industry. At first the growth of the so-called independent telephone movement resulted in two telephone systems in many places. This condition of duplication and waste has now been almost eliminated. There are in existence today about nine thousand telephone companies independently owned and controlled, interconnecting with the general telephone system of the country and through that with each other. These independent telephone companies operate more than four million stations and have become a prominent part of the telephone system of the United States. Through their enterprise and activity they are performing a service of great value.

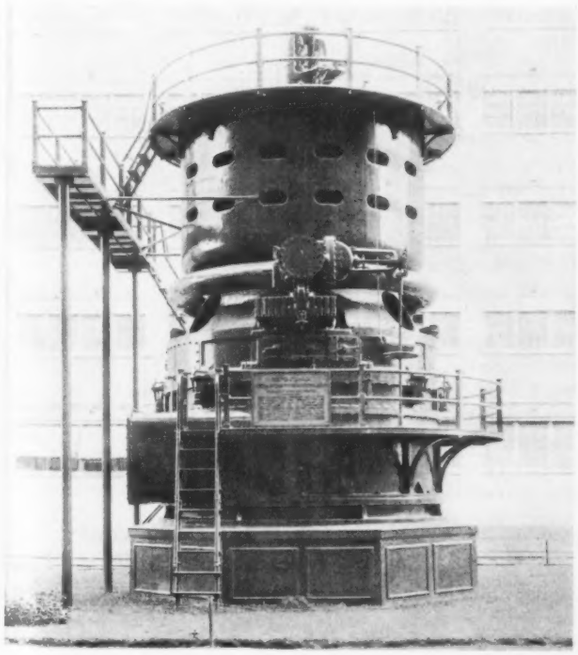
TABLE II—NUMBER OF TELEPHONE STATIONS IN UNITED STATES

Year (Jan. 1)	Bell System Owned Stations	Bell System Connecting Stations	Bell System Total	Independent	Total Bell and Ind'p'nt	Stations per 100 Population
1880.....	30,872	.....	30,872	.....	30,872	0.062
1885.....	147,715	.....	147,715	.....	147,715	0.263
1890.....	211,503	.....	211,503	.....	211,503	0.34
1895.....	270,381	.....	270,381	15,000	285,381	0.41
1900.....	666,733	10,000	676,733	328,000	1,004,733	1.33
1905.....	1,838,034	167,213	2,005,247	1,348,000	3,353,247	4.02
1910.....	3,522,079	1,620,613	5,142,692	1,853,000	6,995,692	7.65
1915.....	5,584,853	3,073,759	8,658,612	1,387,806	10,046,418	10.05
1920.....	7,739,159	4,056,588	11,795,747	872,727	12,668,474	11.98
1924.....	10,406,155	4,593,946	15,000,101	369,353	15,369,454	13.82

From the very beginning of the industry its founders had clearly in view a national telephone service as the ultimate goal, and their successors have consistently directed their efforts to the creation of a national as distinguished from a sectional service. The organization which experience has shown to be best adapted for supplying telephone service in the United States consists of associated companies, each furnishing local telephone service and, in general, toll telephone service within definite territorial limits; a manufacturing, purchasing and warehousing company; a long-lines department, which constructs, maintains and operates the lines connecting the territories of the several associated companies, and a central headquarters staff, directing and performing development and research work and standardization and furnishing consulting and advisory legal, engineering and financial services to the associated companies.

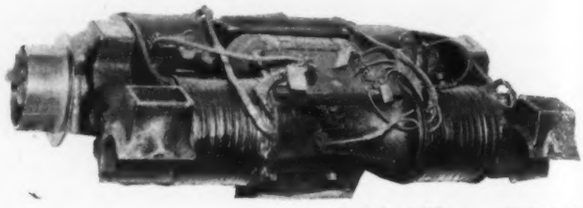
The plant owned by the Bell System (omitting the independent connecting companies) contains, as already stated, more than thirty-four million miles of wire. About 66 per cent of this mileage is in underground cable, more than 22 per cent in aërial cable, and less than 12 per cent in open wire. The book value of this plant is approximately two billion dollars. There are nearly three hundred and fifty thousand employees in the system, and the daily number of telephone connections is in excess of forty-two million.

First Large Curtis Steam Turbine



Originally owned by Commonwealth Edison Company of Chicago and now erected in yards of the General Electric Company to commemorate beginning of steam turbine industry

Tabloid History of the Electric Railway



Original "Sprague" Double Commutator 7½-Hp. Railway Motor Used on Richmond Street Railway in 1888

Practical attempts to use electrical energy for traction followed the modern dynamo—Methods of 1879 and subsequently—Richmond line established success of the trolley

By Frank J. Sprague

President Sprague Safety Control & Signal Corporation

THE electric railway is not a specific invention nor the product of an individual, but a composite of many inventions and suggestions of varying importance made at different times during a period of more than three-quarters of a century. It was inevitable that the epoch-making researches of Henry and Faraday would be followed by a proposal to use a motor supplied from a source of electrical energy to propel a car, even with all the crudities of early construction and the limitations of the primary battery.

Hence we have the ambitious attempts of Thomas Davenport, the Vermont blacksmith, in 1834, and the prophecy of Le Conte five years later "that electromagnetism will at no distant day compete with steam as a motive power, and successfully." Farmer in 1847 and Page in 1851 each operated a small car, but, like the work of all others during this period, these tests were of no practical importance because of the lack of a suitable motor and of the modern dynamo for converting mechanical energy into electricity.

The development of the dynamo covered a period of fully twenty-five years, from the work of Wheatstone and Cook in 1845 to that of Pacinotti, to whom must be awarded the invention of the continuous current dynamo in 1861, and that of Gramme, who nine years later embodied in a single organization the vital features of the Pacinotti machine and the principle of self-excitation, discovered independently by English, German and American inventors three years earlier. Then came the drum type of winding invented independently by Von Hefner Alteneck of the Siemens firm and Rowland of Baltimore.

In 1873 was made apparently the first demonstration, by Gramme and Fontaine at the Vienna Exhibition, of the remarkable characteristic of reversibility of function. This dual characteristic of the dynamo-electric machine was declared by Maxwell to be one of the greatest of modern inventions. It is claimed that Pacinnoti made a like discovery six years earlier, but the record is not conclusive. From this discovery there followed the natural corollary, the electric transmission of energy by the use of two machines in the same circuit, one driven by power and generating electricity and the other receiving electricity and developing mechanical power.

It was not, however, until some time later that there was any real attempt to make use of the fundamental inventions which had opened wide the way for a successful application of early suggestions for electric propulsion. In 1879 an American mechanic named Green applied for a patent and the Siemens firm operated a small car at the Berlin Exhibition, repeating this at other exhibitions at Munich, Dusseldorf and Frankfort. Stephen Field in the same year disclosed a plan for operating cars with electricity carried by conductor in a slotted conduit, the development of a study two years earlier of cable operation in San Francisco.

In the following year Edison, using one of his small lighting dynamos as a motor, operated a car at his laboratory at Menlo Park, the mechanical power being transmitted to the axle by belt. The current supply was through the two rails, insulated from each other, and the wheels, which were also separated by insulation. In the same year Siemens, Field and Edison became involved in a patent interference in the United States, finally decided in favor of Field, Siemens being ruled out technically under limitations as to admission of foreign disclosures. But to the latter probably belongs the credit of operating the first commercial road, a single-car line a mile and a half long opened for traffic at Lichterfelde in May, 1881. The current was at first supplied through the rails, but later, at the Paris Exhibition, an equipment made use of two slotted tubes, carried on poles, in which were operated skids held in contact by spring-pressed wheels, the collecting units being connected to the car by flexible cable. Some years later the Lichterfelde road adopted two overhead conductors, over which a small trolley was dragged along by a car-connected cable.

In 1881 Hopkinson and Sprague independently invented the series-parallel combination of motor circuits, and later Reckenzaun and Condict added graduating external resistances operated by the same switch movement. In the following year there were several serious projects by the Siemens firm—an experimental road to demonstrate the possibilities of electrification for the St. Gotthard Tunnel, small lines at Frankfort and Molding and a proposal for an elevated and underground road in Vienna. Finney devised a system of operating omnibuses from an overhead wire carrying a traveling trolley, Ayrton and Perry read a paper on automatic railways before the Royal Institution, and Jenkin proposed a system of telpherage.

In the same year Field undertook some isolated experiments, and Edison repeated his Menlo Park experiments on a larger scale, while Sprague applied for a patent covering the main and working conductors and means for maintaining the voltage on a wire conductor, following this with the invention in the same year of the modern trolley, which conception resulted from a study of the difficult conditions imposed by the switches of the under-

ground railway of London. The system then proposed was based on the use of the tracks as one conductor, the other comprising a system of overhead conductors in one plane, following the center line of all tracks and switches, contact with which was to be made by an upward-pressing wheel carried by the car over the center of the truck and supported by springs to accommodate the varying motion of the car.

About this time the Belgian wood-worker, Van Depoele, who had become interested in electrical work, attacked the railway problem energetically and left a permanent impress upon it. In his first experiments, at his works in Chicago in 1882-83, he used an arc-light dynamo as a motor, the current being taken from a wire carried in a trough. It is also claimed that about this period he used an overhead wire with an under-running contact wheel, this forming the basis of an interference, in patent applications made three years later by Van Depoele and Sprague, which was decided in favor of Van Depoele because Sprague's invention was made abroad while on naval duty, the admission of his evidence being, therefore, limited by rules intended to protect an American against foreign inventors. The inventions were made independently, but Sprague was apparently actually the earlier.

Commercial Use Begins

The electric railway was now in the throes of commercial birth, and the next four years were marked by a number of independent constructive efforts, among which should be mentioned the installation of the Portrush Electric Railway in 1883 by Siemens of London, under the direction of Dr. Hopkinson, and the work of Daft, who conducted his first experiments in Greenville, N. J., in 1883, and later in the same year operated a locomotive called the "Ampere" on the Saratoga & Mount McGregor Railway. A year or so later Henry installed and operated in Kansas City a railway supplied by two overhead conductors, on each of which was carried a small trolley connected to the car by a flexible cable.

In 1885 Van Depoele operated a train pulled by a dummy at the Toronto Exhibition, Daft installed small exhibition roads at seaside resorts, Bentley and Knight equipped a short conduit system on the tracks of the East Cleveland Horse Railway Company, and Short and Nesmith a short conduit section in Denver, using a system in which a constant current was sent through the different motors in series, with automatically sectionalized conductors.

Meanwhile Daft had continued his activities and, aided by Thomas C. Robins, began work on the Hampden branch of the Union Passenger Railway in Baltimore, at first using two motors which pulled regular street cars. The current was taken from a center rail, with track return, except at crossings, where an overhead conductor was installed, the connection to which was made by a hinged arm carried on the car and pushed upward by a spring. This crude installation was probably the first regularly operated electric road in the United States, and encouraged by his success Daft undertook the equipment of a two-mile section of the Ninth Avenue Elevated Railway in New York, where in 1885 he operated a locomotive called the "Benjamin Franklin," pulling a train of cars. The experiments were soon suspended and not resumed until three years later with a rebuilt motor.

In 1885, also, Van Depoele resumed operations at Toronto, where he used an overhead wire with under-contact, and followed this with his first commercial installation at South Bend, Ind., and then one at Minneapolis, these being supplemented by five small ones the following year. Among these was a road in Montgomery, Ala., where he used a non-reversible under-running trolley carried on the forward end of the car, although on some other roads a traveling trolley was carried by the overhead wire. The Montgomery operation was terminated by a fire.

Meanwhile Sprague, who had been actively engaged in the development of the industrial motor and had in connection therewith invented a method for automatically maintaining the non-sparking point of the brushes and also the method of regeneration, or the sending of power back to the line by the motor when operated by a load, resumed consideration of the railway problem, and in December, 1885, before the Society of Arts in Boston, fully outlined a method of operating the elevated railroads in New York by using shunt motors geared to the axles of the trucks on the now universally adopted wheelbarrow method of gearing and suspension, and electric braking by control of the motor fields, first for sending current back to the line and then for stopping the trains on short-circuited armatures.

The construction of two motors already being under way, this proposal was followed by several months (1886) of actual demonstration on a private track in New York, and then with a car on the elevated railroad, where there were also demonstrated dual propulsion and braking control from each end of a car, single sets of brushes for operation in both directions and automatic control of a non-sparking point through a series coil wound at right angles to the normal field winding.

Status of Art in 1887

Reviewing the situation at the beginning of 1887, there had been installed in Europe and America about a dozen experimental or commercial installations of variable extent and of widely differing characteristics, none of which was a precedent for commercial development. Then came the justly famed installation by the Sprague Company of the Union Passenger Railway at Richmond, Va., which, because of its successful combination of old and new ideas, the extent of its equipment and the difficulties surmounted, established its supremacy and justified its claim as to the pioneer modern electric railway.

This single installation comprised more motors than existed on all other roads combined. Contracted for in May, 1887, it began regular operation in February of the following year. For many months commercial success was jeopardized by an adverse combination of technical and financial difficulties, but in spite of these the installation gave an impetus to electric railway installation represented within two years by about two hundred roads contracted for by the Sprague and Thomson-Houston companies, the latter having taken over the Van Depoele interests and an ultimate investment of billions of dollars.

The features of the Richmond equipment, which, despite the many natural improvements in detail construction, characterize practically all trolley railroads today, were the main and working conductor with rail return, universal under-running contact, centrally supported wheelbarrow motor suspension, dual electric equipment, fixed-contact brushes, series-parallel control and lightning arresters. Franklin Leonard Pope, in a historical sketch read before the Electric Club in 1891, referred to this pioneer enterprise in the following words: "Laboring under enormous difficulties and drawbacks, Sprague succeeded, by the completion and operation of this [Richmond] plant in establishing beyond peradventure the future supremacy of the electric street railway, and many of the characteristic features at that time designed and

introduced by him have practically become standards in the modern system and are found in nearly every one of the thousands of cars now in service."

The final success of the Richmond road brought about the adoption of electricity on the West End road of Boston, in the place of cable, and there was initiated by Henry Whitney the modern consolidation of street railroads. In 1890 the Sprague company was absorbed by the Edison General Electric, after which there was a brief abortive attempt by the latter to establish a low-potential rail supply in place of the trolley.

Meanwhile the Westinghouse company entered the commercial field, and the Edison and Thomson-Houston companies were combined into the General Electric, the record of the intervening and succeeding years being that of an extraordinary industrial development, with continuous improvement in, and increase in size of, apparatus. Form-wound armatures, proposed by Eickemeyer, replaced irregular windings, and metallic brushes gave way to carbon, this single change, initiated by Van Depoele in 1888-89, with the magnetic blowout of Thomson and Potter, going a long way toward making the art a success. Cast iron and wrought iron yielded to steel, two-pole motors to four, double reduction gears to single, and open motors to closed ones, protected by their own castings.

The use of grounded rail circuits by electric railways soon added serious difficulties to those already being experienced by the telephone companies, which likewise were using earth return. The first attempt to correct this interference was the use at the Richmond Exchange of a common-return wire insulated from the ground. But with the spread of the telephone industry this proved quite insufficient correction, and after many legal battles the telephone adopted the completely balanced individual return circuits which in the present state of the art are vital to its existence.

Alternating Current Arrives

The following years were marked by many improvements in construction, but with little change otherwise, until the development of the system of alternating-current transmission and the means of conversion of alternating into continuous current through the inventions of Tesla, Bradley, Lamme and others, when advantage was taken of these inventions to expand the extent of operation. The Richmond road had been operated at about 450 volts direct-current potential, but Sprague had pointed out that this potential must be raised, possibly to 3,000 volts, on trunk-line operation. The alternating-current system made possible transmission at any required initial potential, with any desired secondary potential from local substations.

Trunk-line development was limited until the advent of the alternating-current transmission, and then its first most effective direct use was with polyphase motors, taking current from two overhead lines and the track and returning current to the line on down grades, this system providing for practically constant speed and constant spacing.

Although the equipment of trolley roads had naturally been followed by construction of electric locomotives, or sometimes by motor cars intended to haul trains, there were few attempts really to replace steam operation. Among the first of the heavy operations were the equipment of the South London railroad in 1890 with gearless locomotives, the construction of a 1,000-hp. locomotive for Henry Villard by Sprague, Duncan and Hutchinson in 1893, a still larger locomotive made by the General Electric Company in 1895 for operating trains on the Baltimore & Ohio Railroad, and the Swiss-Italian tunnel equipments.

But all proposals which simply followed steam precedents fell short of the possibilities of electric train operation, and in 1895, making use of certain features in the development of electric elevators which were operated by master switches and distant control, Sprague invented the multiple-unit system—a system of train control permitting the making up of trains of any length by the combination of units, a part or all of which are equipped with motors, but all with train lines, without regard to number, end relation or sequence, with control of the train from either end of any car by a master switch connected with the train line, the system being equally applicable, of course, to any combination of locomotive units. This system was first adopted for the equipment of the South Side Elevated Railroad of Chicago in 1897, and it is now in universal use for all electric train operation where two or more motor units are under a common control. Without it the present capacity, for example, of the subways of New York City could not be duplicated by new construction at a cost of less than $150,000,000.

A grave accident at the New York Central Terminal led to the first large important electrification in connection with steam-railroad operation in this country, this being carried out on the direct-current system, using a third-rail at 650 volts potential, supplied from substations, where alternating current at 13,000 volts was reduced and converted. The locomotive used marked a radical departure in construction, invented by Batchelder, a bipolar type in which the armatures are carried directly on the axles and the field magnets, with flattened pole pieces, form part of the locomotive superstructure carried above the springs, free vertical play being thus permitted without the restrictions of concentric relation.

This equipment was followed by that of the New Haven road, where a single-phase trolley is used, with reduction and variation of pressure through transformers carried on the locomotives, which supply alternating currents of varying potential to single-phase motors. Despite the successful operation of this installation, it is doubtful if the so-called single-phase system, as it was defined and understood when this road was equipped, will ever be generally adopted, because of certain inherent limitations in capacity and in line losses.

Following these installations direct-current potentials with interpole motors, as proposed by Sprague, have been raised to 3,000 volts, as, for example, on the great locomotives of the Chicago, Milwaukee & St. Paul Railroad, and regeneration has been adopted for braking trains on down grades. An alternative in the single-phase development is the single-phase trolley, with conversion on the locomotive into split phase, used in connection with a polyphase motor, as on the Norfolk & Western road, because of the limitation of the single-phase motor *per se*.

Meanwhile the advocates of the merits of direct-current and alternating-current systems, while perhaps less pronounced in their public expressions of belief, are by no means reconciled; but it would seem that common sense would dictate that in so far as possible the best features of alternating-current and direct-current practice should be combined, and it is quite certain that in the larger development of power-station supply for the community the railroad will not remain an independent entity but will get its current from a unified central-station system and hence be largely subordinated to it.

A Quarter Century of Radio

From signaling by Hertzian waves to the long-distance entertainments of today—Many early devices, once abandoned, are being rediscovered and put to use

By Lee DeForest

President DeForest Phonofilm Corporation, New York

THE progress in radio of recent years has been so astonishingly rapid and has developed so completely away from the lines which were first laid down in the initial days of wireless that a brief résumé of those early days is not so easy as it might appear. Few who are at work in the art today are themselves familiar with the primitive apparatus in vogue twenty-five years ago. One must go to the museum shelves to find any of the apparatus which was considered essentially modern and as marking progress in the then infant art.

Our mastery of the science of radio has advanced so rapidly that in looking back it is difficult to realize the meager state of information and collected data upon which pioneers were compelled to build their progress. Although the first demonstration of the practicability of signaling by Hertzian waves occurred in Europe from 1896 to 1900, it did not take the American investigators long after they had set themselves to the task to appreciate the essential shortcomings of the European apparatus and to get completely away from the primitive coherer, tapper and Morse inker, which had been considered indispensable abroad; to substitute for the Ruhmkorff spark coil alternating-current transformers and begin the development of wireless along more truly engineering lines. It is true that the conception of the upright aërial and the earth connection anticipates any practical work done in America, but the theory of the two-tuned circuits at transmitter and receiver, the importance of diminishing as far as possible damping in the oscillating circuits, the theory of closely and loosely coupled circuits, etc., was first worked out in this country, notably by John Stone Stone.

It is only fair to point out that in this period (from 1899 to 1905) very much of the fundamental theory and many conceptions which have piloted radio engineers up to present-day development were laid down. However, the implements for taking advantage of the procedure called for by theory were not at hand. Thus it was not until the discovery of the quench-spark principle by Professor Wein that means were afforded for radiating a slowly damped train from the aërial. In this development Germany was unquestionably the world's leader, just as a Dane, Poulsen, through his important discovery of the arc in hydrogen supplied the means for securing relatively undamped wave radiation. The commercial development attendant on these two important discoveries found its most rapid advance in America. This was particularly true as regards the arc transmitter. Owing chiefly to the foresight and indefatigable energy of C. F. Elwell and the engineers of the Federal Telegraph Company of San Francisco, abundantly encouraged by the generous co-operation of the United States Navy, the high-powered arc transmitters were brought to a basis of operative practicability very far ahead of anything which was done in Europe.

In reviewing the rapid evolution of the wireless art it seems now astonishing that we can already look back at the development of this all-important improvement, the Poulsen arc, as something far remote in history. Ten years ago, at the beginning of the war, this development of the arc transmitter, coupled with Fessenden's heterodyne receiver, made practical by the oscillating audion detector, seemed to be the last word in the refinement of high-powered radio communication. Yet this date, 1914, may well be taken as the line of demarcation between the old and the new radio. The use of the arc, it is true, has continually increased up to the present time, supplemented and in many cases supplanted by the various types of high-frequency alternator, notably that of Alexanderson. But the ever-increasing use of the oscillating three-electrode vacuum tube in every branch of every radio system, the refinement in its manufacture and the discovery of methods for constructing this device to sizes capable of handling 100 kw. or more—all this has wrought a genuine revolution in the radio art, compared with which its rapid progress prior to 1914 was more like a gradual evolution.

Wireless Before the War

In dealing, therefore, with the early days of wireless I shall confine my attention to work prior to the beginning of the world war. Many of us well remember the eagerness—the incredulity on the part of some—with which we read the newspaper accounts of wireless messages having been flashed across the British Channel. Personally I can recall the very real difficulties encountered in sending my first wireless signals across the Hudson River in 1901, and later between 17 State Street, New York, and Staten Island, a distance of 7 miles. It is almost impossible to understand now why just such difficulties were encountered by us pioneers through the veiling light of the vast amount of experience and knowledge which has been accumulating through the twenty-odd years intervening. But the fact remains, those difficulties were at that time very present, very actual and discouraging. Such early workers as Pickard, Schoomaker, Fessenden and myself had started out with the idea that success in wireless telegraphy would necessitate self-restoring detectors with telephone receivers (instead of Morse inkers or sounders), and alternating-current transmitters, giving spark frequencies sufficiently high to permit telegraphing at Western Union speeds—something undreamed of at that time by our European rivals. Consequently we saw at

the period of the international yacht races of 1903 a speed of word transmission of twenty-five to thirty-five per minute. We also experienced a deplorable amount of interference from static disturbance and willful obstruction, which showed us vividly how unprotected and liable to disturbances and interruptions was the wireless communication of that date. Lessons learned during that event resulted in an intensive study of the problem of interference and methods for overcoming it, in working out which we found the greatest amount of theoretical guidance and suggestion from the writings and teachings of John Stone Stone.

Early "C & C" 7½-Hp. 220-Volt Shunt-Wound Motor

Early in the spring of 1904 wireless messages were first transmitted 180 miles over land, between Buffalo and Cleveland. During the ensuing summer at the St. Louis Exposition this distance was increased to 300 miles—between that city and Chicago, where a commercial wireless-telegraph service was then first established and more or less successfully maintained. This demonstration at the St. Louis Exposition was made the subject of an elaborate test and report on the part of its electrical committee of awards, of which Dr. C. P. Steinmetz was a member and William J. Hammer chairman. I well remember the astonishing precautions which this committee took in its efforts to make certain that there was no hocus-pocus in the claim that wireless messages were actually transmitted from the fair grounds to a receiving station in Chicago. This skepticism was doubtless justified, considering the fact that this overland transmission had never before been attempted; but to the radio fan of today who nightly listens in to telephone stations one thousand to three thousand miles away this attitude of mind on the part of learned electrical engineers just twenty years ago this summer must seem astonishing.

Radio Audiences Unknown in 1904

In those days, before the advent of the oscillating three-electrode generator and even before the crude arc-telephone transmitter, there was no radio audience outside of governmental and a few scattering commercial wireless stations. Consequently interest in the art was limited entirely to the few who were directly concerned with its development for commercial or military purposes. The literature was chiefly limited to the one or two foreign periodicals, and in this country to a very occasional paper before the Institute of Electrical Engineers or in one of the electrical journals. Certain promoters, misled by the seeming miracles which were being accomplished by transmitting messages over considerable distances without wires, took advantage of the awakening public enthusiasm and, basing their predictions on the successes suddenly attained, without waiting for the test of time to determine how reliable this new service might be, expected a mushroom growth of wireless telegraph stations all over the country. As a result of these misconceptions and ill-directed developments millions of dollars' worth of stock was marketed in various wireless-telegraph companies. Most of the money thus taken in was dissipated or wasted, with the inevitable result of a serious setback in the development of the new art, one which proved disastrous to all concerned. Yet, although many of the predictions of that time as to the coming universality of wireless-telegraph communication everywhere at only nominal toll rates proved wrong, another vision and prophecy as to the coming application of widespread radio-telephonic distribution of entertainment and information valuable to the masses dates from that period and has already abundantly proved its correctness. Long after I had published such a prediction in 1907 the broadcasting of opera music was actually realized from the stage of the Metropolitan Opera House in New York. A night when Caruso was singing was selected for this first radio effort. Ships in the harbor or just sailing were advised of the event and made up a large part of the radio audience, which was, of course, at that time very small. The attempt was ten years in advance of the times. In 1906, prior to the advent of the audion, several lines of development had been laid down to be subsequently abandoned as either impracticable or far in advance of their need, only to be taken up again quite recently and found to offer an important solution to problems which have baffled experimenters and radio engineers for the past twenty years. Notably among these I may mention the use of the short wave combined with parabolic reflectors to give relatively straight-line transmission. This arrangement, which begins to approach economy of transmission and enormously reduces the probability of interference, was outlined and patented in a form particularly applicable to use at sea as early as 1906. Recent work by the Westinghouse company in this country and the Marconi company in England has demonstrated the extreme utility of the short-wave transmitter device, which in its crude form was cast aside in 1903-19 in favor of the use of ever-increasing wave lengths.

I venture to say that we do not even now begin to appreciate generally the immense utility of the short wave length; that ere long radio engineers will hark back to the first pioneering work of Hertz and will appropriate to the use of ship-signaling in fog, and to other vitally important uses, the extremely short wave lengths which were originally investigated by that master.

Another less spectacular instance of very modern applications of a principle originally old and almost forgotten is that of the "rejector" circuits, wave filters, etc., all of which were fundamentally investigated and their laws carefully laid down by John Stone Stone in his papers and patents on these subjects, documents which should be truly considered classics in the art.

Radio Replete with Rediscoveries

The history of radio development is replete with such instances where some pioneer, working long ahead of his time or of the public needs, has discovered some principle or invented some device which later on, when the need for it arises, is again rediscovered or reinvented—too often, alas! with complete failure to recognize the historical verities involved. As further example of this tendency I might cite the use of the two-grid audion, which dates from 1908 in the United States and was brought to great technical refinement in Germany in 1919, but only within the last few months "rediscovered" in England with a great fanfare of publicity. Many similar instances will suggest themselves to radio engineers and students of the art whose experience or reading goes back to early days when pioneers, possessing far vision and little deterred by the actual practical limitations of their art and its public patronage, mapped out lines of development or conceived inventions, the benefits of which were to be reaped not by themselves but by those who should come after.

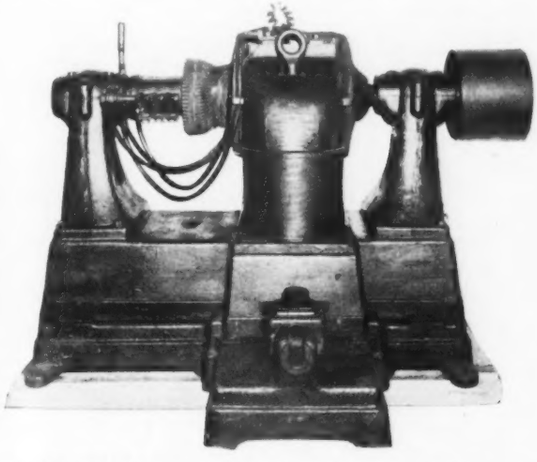
Pioneering with the Thomson-Houston Company

Early Thomson-Houston Spherical Armature Arc Dynamo, Commutator with Brushes, Regulator and Air Blower Removed

Early devices of the Philadelphia high-school teacher who became head of the pioneer manufacturing firm—Making alternating current safe—Van Depoele and the carbon brush

By E. W. Rice, Jr.
Honorary Chairman General Electric Company

IN 1878 the Franklin Institute decided to purchase a dynamo-electric machine and appointed Professors Elihu Thomson and Edwin J. Houston a committee to conduct the electrical tests of those offered for sale, which consisted of two Brush, two Wallace-Farmer and one Gramme machine, each of these being able to operate but a single arc light. The results of the tests were published in 1878 in the *Franklin Institute Journal*, which, it is believed, contained for the first time the results of definite measurement of the resistance of a dynamo-electric machine, the resistance of the arc, the variations of arc resistance in accordance with the strength of the current, the energy consumed in running the machine and its efficiency.



A "D-40" Thomson-Houston Compound-Wound, Direct-Current, 110-Volt Dynamo of 1888

In 1879, while a student in the Central High School of Philadelphia, I attended a lecture on electricity given by Professor Thomson at the Franklin Institute. He exhibited at that time an arc dynamo operating an arc lamp of his own design and manufacture. The dynamo was interesting, as its armature contained two coils at right angles to each other, supplied with commutator segments and collector rings, so arranged as to produce both alternating and direct current. It was, in reality, what would now be termed a two-phase, self-excited, series, alternating-current dynamo.

On the occasion of a second lecture Professor Thomson showed a very striking and original experiment in which the primary windings of two transformers were connected in parallel to one of the phases of the alternating-current dynamo above mentioned, while the heavy wire secondaries were used to deliver energy to small vibrating arc lamps. This was the first instance, so far as I am informed, of the parallel connection of induction coils, now known as transformers, operated with a reduction of electrical pressure from the primary to the secondary circuits.

About this time Professors Thomson and Houston invented the three-coil armature provided with a three-segment commutator. The first machine of its kind was wound and largely constructed by Professor Thomson himself and was immediately put into commercial operation. It was capable of operating nine arc lamps of 10 amp. in series. The application for the patent of this machine disclosed for probably the first time in history a three-phase, Y-connected alternator. Professors Thomson and Houston, with the financial assistance of George S. Garrett of Philadelphia, then started in a small way the manufacture of the three-coil arc machine above mentioned.

Professor Thomson resigned his position as professor of physics and chemistry in the Central High School, Philadelphia, and moved to New Britain, Conn., in 1880, a company having been organized under the name of the American Electric Company to manufacture electrical apparatus in accordance with the inventions of Professors Thomson and Houston. I gladly took a position offered by Professor Thomson as his assistant in this enterprise.

Some months previous to the starting of the work in New Britain Edison had caused great excitement by the announcement of his discovery of what was then termed the "subdivided electric light," which was embodied in the carbon-filament incandescent lamp. About this time also Charles F. Brush was manufacturing a series-arc machine and arc lamps and had obtained patents on the machine, the lamps and the electroplated carbons.

The Thomson-Houston machine had one great advantage over the Brush in that it was furnished with an automatic regulator which maintained a constant current independent of the variations in the load. This automatic regulator made it possible to vary the number of lamps on

the circuit at will, with a corresponding reduction in energy, and without interfering with the successful operation of the remaining lamps. Without this regulator it was necessary to substitute an equivalent resistance for other lamps in the circuit whenever a lamp, for any reason, was cut out of use.

Mr. Brush was the first to discover a method of operating a number of arc lamps in series on a single circuit. He used for this purpose a differential control magnet. He obtained a patent on this method of controlling the arc lamp, with claims which purported to cover all forms of differential control of arc-lamp mechanism.

In his early lamps Professor Thomson controlled the feeding by a different system called the "drop and lift" system, in which the shunt magnet closed a short circuit around the series magnet when the arc became long enough to require feeding. The effect of this short circuit was to drop the carbons together for an instant and so produce an unpleasant, although momentary, winking in the light. He afterward devised a form of differential control which consisted in placing the series magnet and shunt magnet at opposite ends of a seesaw or walking beam, thus producing a differential effect which avoided the Brush patent, in which the differential action was produced by superimposing the shunt and series windings upon the same magnet.

The First Measuring Instruments

It is interesting to note that in 1880 electrical measuring instruments were extremely limited, not only in type, but also in the number in actual existence. When we started the factory in New Britain, Professor Thomson made a long search in New York to discover current-measuring instruments and could only obtain a Western Union tangent galvanometer from the office of that company itself. This was brought to our factory at New Britain and calibrated by the method of copper deposition. Professor Thomson also brought from Philadelphia a 10-ohm resistance unit which he had made himself, a copy of the high-school standard box made by Elliot of London. We then made a Wheatstone bridge and an astatic galvanometer and used the 10-ohm resistance unit as our standard reference for several years.

Professor Thomson also immediately designed and made what we called a "herringbone" galvonometer, an instrument almost identical in construction with the one afterward known as the Deprez galvanometer. This Thomson instrument was set up in our test room and used to measure our standard current for several years.

Our first machines operated about ten arc lamps of 9.6 amp., giving nominally 2,000 candles. Machines of larger capacity were demanded, and one to operate twenty arc lamps was designed. This machine was found to commutate in an unsatisfactory manner in that, after running nicely for a short time, it would arc over from brush to brush on the commutator. This flashing would short-circuit the armature and temporarily extinguish the lights on the circuit, with, naturally, unsatisfactory results.

Professor Thomson tried many schemes to make it possible to operate the machine with a single commutator, but none of the methods was entirely successful, and the machine remained too sensitive to withstand the rough usage of those early days. The only solution seemed to be the method already practiced by Brush, of using two commutators in series, which, by reducing the potential across the commutator to that of about ten lamps, gave commutating conditions as satisfactory as those which existed on the ten-light machine. However, the use of two commutators introduced serious complications in the automatic regulator, and Professor Thomson longed for the simplicity of the single commutator and insisted that some method could be devised to make a single commutator entirely practical. Eventually he designed a simple three-bladed blower which introduced a powerful jet of air at the proper time between the segment and the brush. When this was placed upon our twenty-light machine, we found that its performance far exceeded our most enthusiastic expectations. It was impossible to make the commutator flash.

The practical bearing of this upon our business success was almost as important as the regulator itself. It meant that the Thomson-Houston machines were "foolproof" and would operate successfully under the most extraordinary conditions of use and abuse.

Thomson Invents Lightning Arrester

An interesting example of Professor Thomson's foresight occurred at about this time (1880). He had often observed the powerful inductive effects of lightning on telegraph wires and was certain that such effects would be present in the extended circuits used in connection with arc lighting. To forestall this trouble, he invented the lightning arrester, which was put into early commercial use for the protection of heavy electrical circuits.

It is true that lightning arresters had been used with telegraph lines, but these arresters consisted simply of a small air gap placed between the line and the ground. Such a device could not be employed with a dynamo-electric machine because the dynamic current would follow any spark to earth and produce a destructive arc in the lightning-arrester gap. It was essential to provide some means for automatically interrupting the flow of the dynamo current.

The matter was being discussed with Professor Thomson one day, when he stated that the way to accomplish the desired result was to make use of the fact that an electric arc was a conductor which could be moved by a properly disposed magnetic circuit. He took a steel permanent magnet and showed how readily the magnetism would blow out the arcs of the lamps in our testing room.

His first lightning arrester, which resulted from this simple but striking experiment, consisted of a pair of heavy brass castings with long horns (the first of the present well-known "horn" lightning arresters), the gap of which was surrounded by the poles first of a permanent magnet and afterward of an electromagnet. As soon as a discharge from lightning induction came over the line and crossed the gap of the lightning arrester at the narrowest point, a dynamic arc would follow, but this arc would be immediately impelled upward by the magnetic field, rapidly increasing in length until it broke harmlessly at the tips of the horns The first model of this lightning arrester was immediately put into commercial use and was manufactured without important alterations for many years.

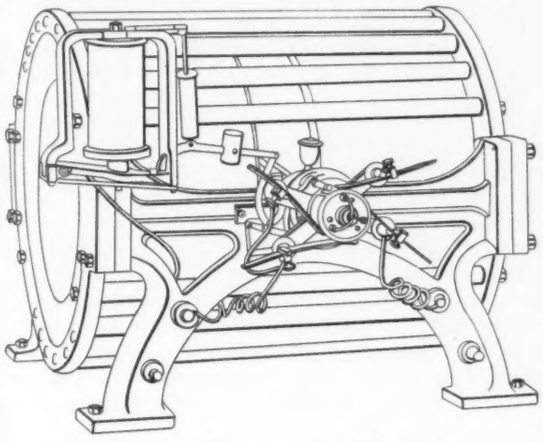
Professor Thomson immediately realized that the principle of this important contribution could be extended to switches, and he made a number of switches in which the magnetic field was used to interrupt the circuit and blow out the arc. It was the first time the magnetic field had been used for such a purpose.

Even in those early days he frequently stated that this principle would find an important and increasing application in the industry. We all are aware that his prophecy has been fulfilled, as the magnetic blow-out principle is used to an enormous extent in circuit breakers, street-car

controllers and switches of many descriptions and has made possible designs and methods of operation which would otherwise have been impossible. It is interesting to note the wonderful simplicity of the idea and the effectiveness of its application.

Making Alternating Currents Safe

In 1883 we moved from New Britain to Lynn and soon thereafter began the manufacture of incandescent lamps, motors for industrial uses, alternating-current dynamos and transformers. It may seem strange that, although Professor Thomson did early pioneer work in the alternating-current field and was an ardent believer in the efficiency and desirability of alternating-current applications, especially the transformer, the Thomson-Houston Company delayed commercial exploitation of the alternating-current system until about 1886.



Thomson-Houston Arc Machine

There were many reasons, such as lack of capital and the fact that our hands were full with the development and commercial exploitation of the Thomson-Houston arc system, but one controlling reason has, perhaps, never been published. That was that while Professor Thomson thoroughly understood the technical advantages of the alternating-current system with transformers, he regarded such a system as essentially unsafe because of the possible danger of fatal accidents.

The alternating-current transformer system was proposed as a substitute for the low-tension, direct-current Edison system, and its contemplated field was largely that of domestic lighting. Of course, the secondary or low-voltage circuit of about 100 volts would not of itself produce a fatal shock. However, in case a contact accidentally occurred between the primary and secondary windings in the transformer, a person touching any part of the circuit—sockets, switches, etc.—was liable to receive a fatal shock, provided at the same time he was in contact with some grounded structure such as water or gas pipe, and also provided that a ground or leak existed between the primary circuit and the earth.

In view of the general distribution of the high-tension network, erected according to the crude methods common in those early days, frequent grounds would occur on the high-tension circuit which would introduce the first dangerous factor; the transformer, as then built, could not be guaranteed against occasional defects between primary and secondary windings which would provide the second element of danger, and the third combination would be found in the faulty interior wiring of houses at that time. Professor Thomson believed that such a system, no matter how meritorious from a technical point of view, was so dangerous to human life that he could not conscientiously permit our company to exploit it.

It is proper to mention that engineers of other companies did not share Professor Thomson's views, but thought that the risk had been greatly exaggerated, that with proper care in installation the system would be reasonably safe, and that the danger in any event was no more than that which was constantly incurred in all advances of civilization. William Stanley and George Westinghouse started a vigorous exploitation of the alternating-current transformer system. Professor Thomson, however, maintained his attitude and postponed our entry into the field for some time—until, in fact, he had evolved methods to remove the danger, either by interposing an insulated copper sheath between the primary and secondary windings, which sheath was carefully connected to earth, or by connecting the secondary circuit of the transformer by a metallic conductor solidly to earth.

Enter Traction Field

Early in 1888 we decided to take up electric traction. This was a field in which Professor Thomson and other engineers had as yet done no work. While we engineers felt satisfied that we could develop a system without outside help, C. A. Coffin, who was the guiding spirit of our company, thought otherwise, and suggested that we would be saved many mistakes, gain time and make better progress by obtaining the co-operation of others who had already accomplished useful work in this field and who were enthusiastic believers in its future. Acting upon this wise idea, the Thomson-Houston Company bought the Van Depoele Electric Company of Chicago and moved its business to Lynn.

As usual in such cases, the most valuable assets proved to be the men who developed the business, and of these, the most important was Charles J. Van Depoele, the inventor. Immediately upon Van Depoele's arrival in Lynn, Professor Thomson and I started the development of his traction system. We decided that the method of placing the motor upon the front platform of the car and driving the axle through a sprocket chain was undesirable, although Van Depoele's reason for such an arrangement was excellent, based as it was upon the necessity of moving the brushes of the motor to avoid sparking when the direction of rotation was reversed or the load changed.

At this time electric motors used only metallic brushes of copper or brass. There was no fixed sparkless commutating point, and the brushes had to be moved with changes of load. The point of sparkless commutation was shifted over a considerable distance during operation. However, the mechanical advantage of placing the motor under the car and connecting it directly by gears to the axle, as already practiced by Frank J. Sprague in Richmond, so appealed to Professor Thomson and myself that we decided to take the risk of unsatisfactory commutation and trust to finding some solution.

We designed a motor with better characteristics than those used by Van Depoele and were able to operate it without shifting the brushes, although the commutation was far from satisfactory. However, the practical conditions of operation, which involved heavier loads and even greater neglect than we anticipated, caused such sparking at the commutator that commutators and brushes were rapidly destroyed and armatures were constantly burning out, and the difficulty of maintaining a road in operation became so great that we became thoroughly discouraged.

Many forms of high-resistance metallic brushes were devised which improved matters but did not solve the problem, and the situation rapidly became desperate. Finally Van Depoele made what seemed to us the absurd suggestion of carbon brushes. We agreed to make a trial. We had some carbon blocks sawed out of battery carbons and equipped one of our railway motors of 20-hp. size with these pieces of carbon for brushes. We were astonished but delighted to find that with brushes placed on the neutral line the motor operated entirely free from sparking, and that even upon reversal of load it ran equally sparkless. Very soon the carbon brush for railway motors was standardized, though, strange as it may seem, it took some time to make up our minds to use carbon brushes on electric dynamos, which could be designed to operate quite satisfactorily with copper brushes, if the commutator received proper care and attention.

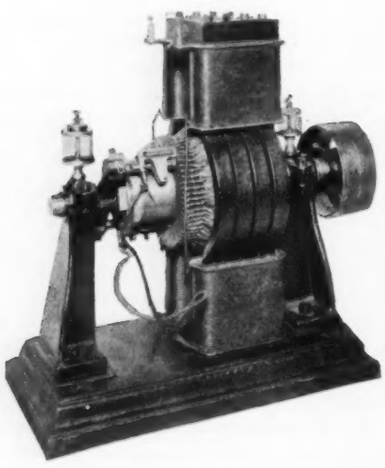
I do not suppose that the present generation of electrical engineers appreciate the revolution which was produced in the design and operation of electric machinery by the advent of the carbon brush. In my judgment it was the most wonderful and valuable advance ever made in the art of commutating machines. No other single element of design compares with it in importance. The technical effect of the carbon brush on the dynamo was not only to reduce the sparking with variations of load and with a fixed position of brushes, but by diminishing the demagnetizing effect of the armature on the field it made possible the adoption of the slotted armature, an increase of the volts per commutator bar and generally permitted a large increase in output per given weight and cost.

Under the influence of the carbon brush, the commutator lost its terrors and today is no longer a troublesome and limiting feature of design. In practical operation it is, in most instances, less troublesome than a set of collector rings. The carbon brush, first introduced by us as a result of Van Depoele's suggestion, rapidly went into extensive use throughout the world and in time replaced all other types of brushes. It was a contribution to the electrical art from a great pioneer, whose name should not be allowed to fade from memory.

About 1889 we purchased the Eickemeyer Company, and, as I have already stated, our most valuable assets in those early purchases were usually found to be the men added to our organization. The purchase of the Eickemeyer Company was no exception, as with this purchase we obtained the services of Dr. Charles P. Steinmetz. The story of his contributions to our work and to the electrical industry is so recent and so well known and appreciated that it needs no further elaboration.

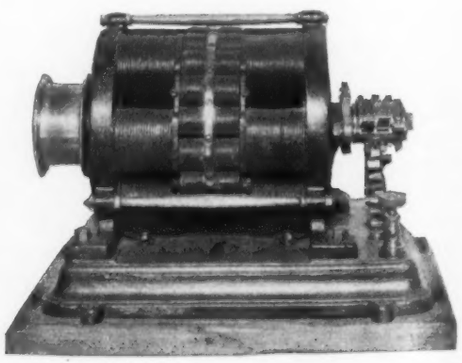
During this period (1880 to 1890) Edison had been busy developing the system which went with his name. He had made the most wonderful contribution of the age in the incandescent lamp, a miracle of simplicity. If Edison had never given us anything but the incandescent lamp, he would still deserve our eternal gratitude. However, he did much more. He developed the fundamental principles and even the details of a complete system of distribution of electrical energy—a system which has been the foundation upon which all others have been forced to build. I refer to his invention of the multiple-arc system of distribution of electrical energy. He insisted, and correctly, that no other method would adequately solve the problem of the generation, distribution and utilization of electrical energy. In no other way can large units of energy be used and added together without limit and electrical energy be distributed and utilized at an indefinite number of points with complete independence of each unit from all other units. This was perhaps his greatest contribution to our industry. In addition, in connection with the development of such a system, he designed dynamos, feeder regulators, systems of underground distribution, meters and other important details needed to make a complete operative system of electrical distribution.

I regret that I cannot do justice to the important contributions made to our industry by such pioneers as Weston, Stanley, Eickemeyer, Wood, Hochhausen, Mather, Knight, Shallenberger, Westinghouse and many others in this country alone, upon whose joint work the marvelous progress of the electrical industry is founded. I regret also that I have been unable to speak of the debt which we owe to the unselfish labor of the teachers connected with the great universities and colleges, whose work in many instances was no less important than that of the great pioneers.



Original "Maxim" 110-Volt, 18-Amp. Series-Wound Dynamo of 1882

Original "Hochhausen" One-Light Series-Wound Arc Machine of 1884

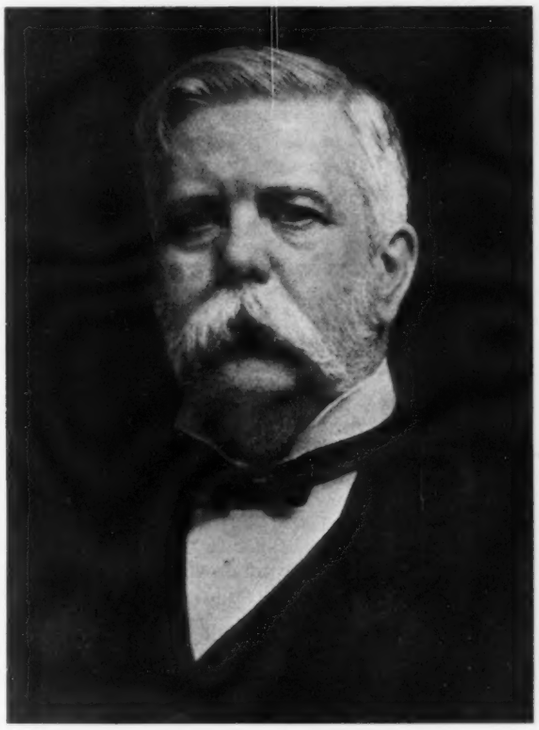


Original "Wood" Series-Wound Dynamo of 1879, Rated at 50 Volts, 9.6 Amp.

Early Days in the Westinghouse Shops

Making the acquaintance of alternating current and its apparatus—How Stanley, Shallenberger, Tesla, Lamme and Westinghouse himself impressed a young engineer in 1888

By Charles F. Scott
Professor of Electrical Engineering
Yale University



George Westinghouse

THE request to tell of the early days in the Westinghouse shops awakens a flood of precious memories. To the youthful newcomer who knew far less of industry and of electricity than he then realized, the incidents and experiences and associates of those days meant much, although they may now seem of trivial consequence to others. But those were the days when electrical engineering was in its bginning. The alternator, the transformer, the polyphase motor—the elements which soon became the controlling factors in shaping the trend of electric power development —were then truly in their infancy, and their cradle was the Westinghouse shops.

In the summer of 1887 I first saw an alternator and a transformer and learned that there was such a thing as an alternating current. I had been graduated from college two years earlier, and I wondered why I had not heard of these things from my professor. Later I learned why; the Gaulard and Gibbs "secondary generators" (transformers) were first brought to this country by Mr. Westinghouse less than two years earlier (September, 1885). The apparatus had been tested, the system had been changed from series connection of primary coil to parallel connection, transformers and alternators of radically new form had been designed and constructed, and numerous plants were in operation when I got a job as wireman at the Baldwin Locomotive Works, where a plant with four 35-kw., 1,000-volt alternators was being installed. I was unable to find out very much about the principles involved in the new system until I read in the ELECTRICAL WORLD a few months later an article by William Stanley. His simple story of alternations and induction and lag and power factor was fascinating, and for me it was the key to many mysteries.

In the following summer (1888) I reached my mecca —the Westinghouse shops. They were on the Allegheny River, about ten minutes' walk from the Pennsylvania station, and there were, I presume, about three or four hundred employees. The principal products were alternators and transformers and accessories for equipping central stations for supplying incandescent lighting. The three-wire direct-current system, with its limited radius of distribution of a half mile or so, was well established in the centers of cities, but could not reach the outlying districts. Unelectrified towns naturally preferred the alternating system, which could supply the whole area. Hence a bitter commercial competition with violent attacks on the alternating system and dire predictions as to its future.

I began as helper in the testing room at night, keeping the field current adjusted on the alternator during its full-load run and measuring the temperature about daybreak. Incidentally there were oil cups to keep filled, brass work to be polished and floors to be swept. The most prevalent alternator was the "750-light" size (35 kw.), and there were others twice as large and occasionally one four times the size which appeared for test. The output averaged a little more than one machine per day, as I now recall, or an annual kilowatt output about equivalent to one medium-sized turbo-generator of today. These machines had cast-iron poles and rotating armatures with smooth cores on which there was a single layer of wire held in place by band wires.

Transformers were of various sizes up to a maximum of forty lights, or 2 kw. The East End station in Pittsburgh was portrayed as a "model lighting plant." A row of single-acting non-condensing engines was belted to a row of alternators. The switchboard had bare bus bars for 1,000 volts, with exposed jaw switches, and there was no insulation except wood. The branch blocks and fuse blocks for house wiring were made of wood. Porcelain insulation and carbon brushes and slotted armatures had not yet arrived.

The alternating system began with two commercial

handicaps—it had no house meter and no motor. The Shallenberger induction meter and the Tesla polyphase motor appeared in the spring of 1888. Both were theoretically difficult but mechanically simple. The first was soon in service on the 133-cycle circuits which were then standard. The motor did not respond to the effort to adapt it to single-phase and high frequency and was a disappointment, but presently the situation was reversed as phases were increased and frequency was lowered to meet the needs of the motor. Today, practically all power is generated and transmitted and nearly all is used as low-frequency polyphase alternating current, as prescribed by the Tesla motor.

Measuring Instruments

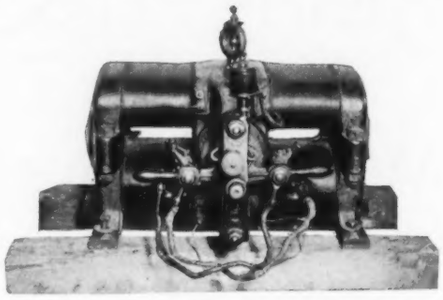
In those early years of alternating-current development there were two laboratory measuring instruments, the Siemens electrodynamometer for current and the Cardew voltmeter. The latter indicated the elongation of a fine wire when heated by current—it took a quarter of an ampere or more for full deflection. Power and power factor involved the simultaneous reading of three dynamometers, one with "split connection," which was liable to instrumental errors and did not inspire confidence. Alexander Wurts worked for many weeks with an ice calorimeter to determine transformer losses which could now be measured in a few minutes.

Electrical courses were just organized in a few colleges; textbooks and literature were meager; to most electrical men alternating-current phenomena were as mystifying as radio is today. The first engineer I met was L. B. Stillwell, who came to the Baldwin Locomotive Works in 1887 to account for a considerable reading on the station ammeter when no lamps were burning; transformer magnetizing current had been considered negligible, but attracted attention in that large installation. Later on he aided my personal application for a job at Pittsburgh and succeeded where six months of correspondence had failed. He also inducted me into the club where a little group of young electricians were keeping house together. Calvert Townley was temporarily away and I tried to sleep during the hot summer days in his third-floor-front room.

O. B. Shallenberger, the electrician of the company, I had assumed from his reputation to be an elderly and profound individual, but when I heard him describe before the N. E. L. A. his street-lighting service system with an inductance coil in shunt to each lamp I found that he was a young fellow of about thirty, pleasing, clear and concise. He combined mathematical training, clear thinking and an intuitive sense of proportion in design. Tesla appeared one evening in the testing room. My boss (a quick-witted fellow whose engineering education had been acquired in his father's sawmill) called me from behind the belts and shafting and whispered, "There comes Tesla." And there he was, straight as an arrow, head erect, chatting a few moments pleasantly, but with a preoccupied air as if new combinations were crystallizing in his brain.

Albert Schmid was superintendent in charge of design and manufacture of machines. He was a master in machine design and won the admiration of his co-workers. Philip Lange was superintendent of the detail department and contributed by his ingenuity and skill to the rapid development of instruments and meters and control devices. He had an apt lad in experimental and testing work, Frank Conrad, now known in radio.

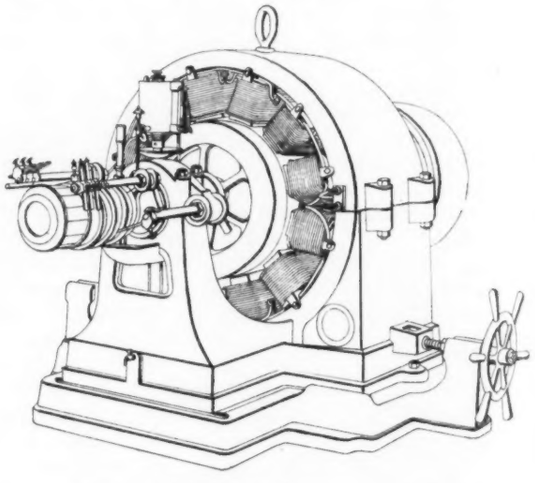
My greatest surprise was William Stanley. His article on alternating-current phenomena had convinced me of his knowledge and wonderful comprehension of the subject. It was he who developed the parallel system of transformer operation and designed the type of alternator then used. His coming to Pittsburgh to test a new machine was heralded as a great event. I remembered the long-bearded picture of Sir William Thomson and expected a replica. I had prepared the circuits for the test when he appeared. He was a little man, slender, smooth-faced



A "Westinghouse" 5-Kw., 110-Volt Shunt-Wound Dynamo Built Prior to 1890

except for a slight mustache, with light-blue eyes, and instead of patriarchal age was only a few years my senior. He was nervous and agile, quick in thought and speech and action. Somehow I had assumed that all knowledge is in books and that wisdom requires age. But the constructive pioneers of the alternating-current system were young men; they entered a new field in which there was no experience to guide and by courage and faith and initiative and hard work they achieved. There was much of "cut and try" in their method, but they cut shrewdly and tried intelligently.

I have been dealing with events during and preceding my first few months in the shops. During the next few years there came from the colleges a group of young graduates who have had an important part in making the shops

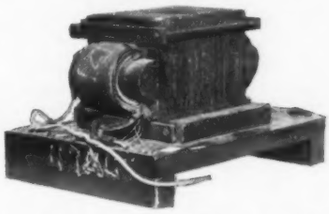


Earliest Alternating-Current Generator for Power Service

and its machines many hundredfold greater than when they came. There were Lamme and Davis, Osborne and Shute, Skinner and Stover and Feicht. Lamme I had known some years earlier as a fellow student in analytic mechanics. At the end of each chapter of "Bowser" there were several pages of problems. The professor suggested that a page or so would be an adequate task. One morning Lamme asked me how many I had done. I made an

apologetic reply and asked him the same question. "Well, I didn't have anything else to do, so I worked them all out."

Shortly after he came to the company Mr. Schmid asked me, "You know that man Lamme? Can he figure?" I said he could. "Then I have a job for him." The first task as I recall was some trouble with the regulator on a Waterhouse arc machine. Soon Mr. Schmid asked Lamme to see if he could not definitely predetermine the

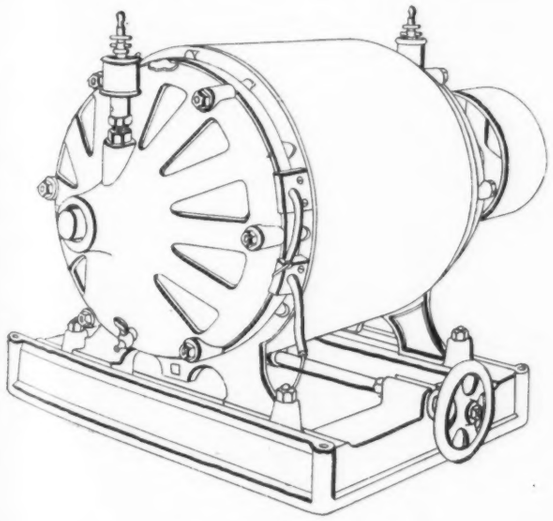


Stanley's Original Transformer
500-Volt Primary and 100-Volt Secondary

electrical and magnetic characteristics of machines, much as their mechanical features were calculated. And he did. With hints from Kapp and others he developed methods of calculation for replacing the "cut-and-try" method. His inventive ingenuity proposed new types to which his intelligent calculation gave definite size and proportion.

Contrary to the experience and advice and warning of others, he made radical changes which have now become universally accepted practice. His ability was unique and his achievements are outstanding. Those who have known him longest and most intimately appreciate most kindly the loss to electrical advancement by his untimely death.

One evening my attention was called to Mr. Westinghouse as he was inspecting the performance of a rotary



Tesla Starting Motor

engine. He aimed to visit it on his way to his office in the morning and after hours in the afternoon or evening. There he stood, with a rod from his ear to the engine as he listened to its internal thumping. A few questions, a few directions to Miller, and he was gone. But there was something about the manner of the man that was impressive—his intent and keen interest in what he was doing, his quick business-like way of leaving when he was done. From what others said and I myself saw I realized that the underlying, dominating force in the organization was George Westinghouse. At every step of the development of the alternating system he had been at hand, suggesting, inspiring, directing, urging. Each step was progress toward a universal system of power distribution. That was his great vision and ambition. Those who saw him playing with his rotary engine (a lifelong fancy, for his first invention when working in his father's shop was a rotary engine) did not realize his conviction that the reciprocating engine must be superseded. Some years later I heard him remark: "I have been working on the wrong principle; I will now take up the Parsons turbine and develop it." And he cast the efforts of years into the scrap heap and began anew. Ere long the rotating turbine, the ideal of his boyhood in new form, and the alternator which he had developed and defended, joined shafts to form a common unit, the turbo-generator, which has put down generation on a new basis of magnitude and economy.

The superpower systems at present and in prospect can be traced back to their fundamental elements in the early days in the Westinghouse shops—the transformer, the alternator, the polyphase motor, supplemented by a rotating type of prime mover. It is about as difficult for the young man of today to picture the state of the art in the early days and to realize how little was then known of what is now common knowledge as it was for those of the early days to imagine the magnitude of what might develop when means were found for making larger generators and larger transformers which would not short-circuit or overheat.

Development of Electric Lighting

Its unique place among other branches of electrical engineering science and practice—Aid and encouragement of the "Electrical World" of great service in the critical period

By Dr. Edward P. Hyde

President International Commission on Illumination

IN TRACING the progress of any large and complicated movement it is often of advantage to withdraw from the center of action and seek some position from which its broader aspects may be observed. Detail may be lost, but a better perspective is gained, and if the observer through experience has acquired a reasonable familiarity with some of the more minute features of the movement, he should have a certain competence to evaluate its progress.

My belief in this thesis emboldens me to venture a comment on this occasion of the fiftieth anniversary of the ELECTRICAL WORLD—one might almost say of the semicentennial of the birth of the electrical industry. In the isolation of my study on the coast of Brittany and without access to the files of the ELECTRICAL WORLD, details are denied me, and yet I can follow clearly in my memory the general course of its progress, particularly in that one of its many fields of service which holds a special interest for me—electric lighting.

Electric lighting is only a part of that larger single group of activities which pertain to the central station, and yet perhaps there is no other one aspect of the electrical industry which has commanded so much attention or has occupied so fundamental and strategic a position. In the beginning it was the *raison d'être* of the central station, and hence the instrument of all the subsequent developments of electric power which the problem of the central station fostered and made possible. It is still one of the most important, if not the most important, source of revenue to the central station; and if it were suddenly abolished through the invention of some non-electrical form of lighting, the plight of the central-station company would be distressing.

Unique Place of Electric Lighting

Moreover, from a scientific and technical standpoint electric lighting has occupied a unique place among the other branches of electrical engineering science and practice. After floundering for many years in uncertainty and ignorance, the lighting problem has more recently attained direction, and there is now a real science and art of illumination.

At the July meeting of the International Commission on Illumination in Geneva not only were the more academic questions of nomenclature and photometry discussed, but much attention was also given to the vital problems of lighting practice; and this international movement is reflected in the activities of each of the countries represented, particularly in our country, which, I am proud to say, has always been in the forefront on the subject of lighting.

In the development of electric lighting in the United States, both on the technical and on the industrial side, the ELECTRICAL WORLD has played a significant rôle. One might select any phase of the electric lighting problem at any period and show how keenly it was perceived and how sympathetically and efficiently it was treated in the editorial columns and in the inspired articles of the ELECTRICAL WORLD. To each of us perhaps there will stand out pre-eminently some peculiar problem and some special period when the co-operation and helpfulness of the ELECTRICAL WORLD were particularly appreciated. I should like to recall such a period and to recall especially one of the many distinguished men who have occupied editorial chairs and to whose wise guidance the ELECTRICAL WORLD in large measure owes its successful career of useful service.

I refer to the late W. D. Weaver, whose simple and genial personality won the hearts of all those who came to know him and to respect and honor him for his broad sympathy and keen intelligence. And I refer to that period almost a score of years gone by, when the science and art of illumination were struggling for formal organization and definite expression. It would be difficult to find any one influence more helpful than that exerted by the ELECTRICAL WORLD under his able guidance in this critical period. Before the Illuminating Engineering Society was conceived the ELECTRICAL WORLD was awake to the importance of fostering the science of lighting, as witness the many articles on photometry and allied subjects which are found in its columns at this period. I shall always remember with pleasure the hospitable reception given to my own humble efforts communicated from the young Bureau of Standards. When the Illuminating Engineering Society was launched in 1906 one of its strongest and ablest supporters was Mr. Weaver, who brought to it the indorsement of the ELECTRICAL WORLD and thus exemplified the beneficent influence of this journal in one of the most significant forward movements in the electrical industry of that period.

I am grateful for the honor accorded me by this opportunity to contribute a word of high appreciation of the meritorious service rendered by the ELECTRICAL WORLD in one phase of electrical science and industry, to extend my heartiest congratulations to those who have been responsible for its editorial policy and its business management, and to offer my best wishes for an equally distinguished and successful career during the next half century.

Inclosed-Arc Lamp

Brief history of its evolution—Drove the open-arc lamp from the commercial field and reached its acme in 1908, after which the magnetite arc and the gas-filled lamps arrived

By L. B. Marks

Consulting Illuminating Engineer, New York

PRIOR to the year 1894 the only arc lamps that were used in commerce were those of the open-arc type. In these lamps the carbons burned about seven hours, after which it was necessary to retrim the lamp. Most of the arc lamps were used for street lighting. As the life of a pair of carbons was too short for all-night burning, it was found necessary to provide for this purpose double-carbon arc lamps, that is to say,

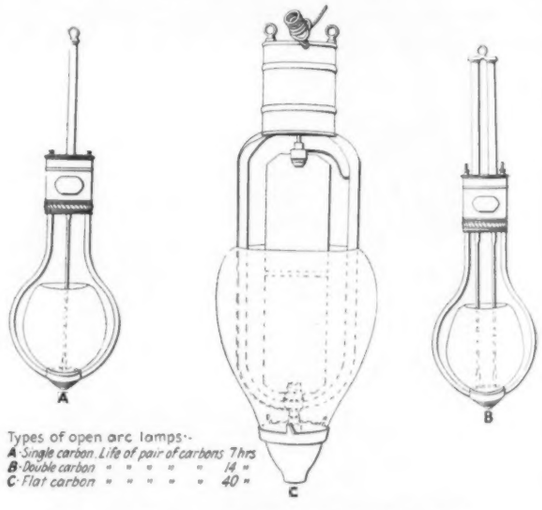


Fig. 1—*Single, Broad and Double Carbon Open-Arc Lamps*

those in which two sets of carbons were used, one set being automatically put into service at the moment the other set had burned away. Thus the time of burning was increased from seven to fourteen hours. Attempts were made to increase the time of burning still further by providing a third set of carbons in the lamp, and later by the construction of magazine lamps containing a large number of carbon pencils which were successively fed as required by the burning away of the carbon. To secure long life of the lamp, very long carbons were tried in

place of the lengths commonly used; the cross-section of the carbons was also increased. (See Fig. 1.) Various forms of economizers were tried for conserving the life of the carbons. The most successful of these was the Hardmuth, which consisted of a metallic frame resting on the tip of the negative carbon and supporting a tube of fire-clay surrounding the lower end of the positive carbon. (See Fig. 4.)

The action of the various economizers was to pre-

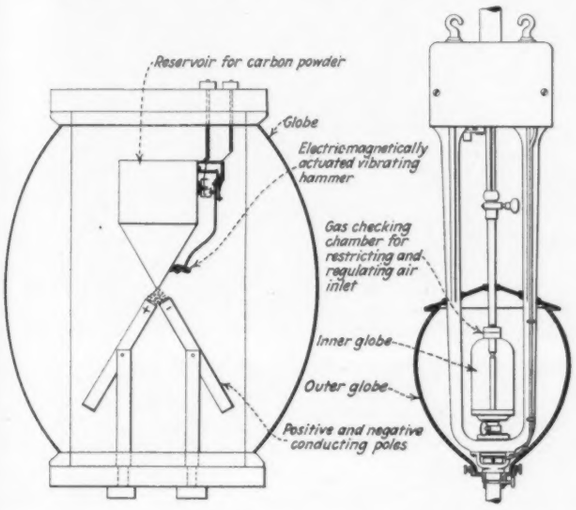


Fig. 2—Varley's Long-Burning Arc Lamp

Fig. 3—Marks' Inclosed Arc Lamp

vent the inrush of atmospheric air to the carbon ends and thus retard combustion. All of these attempts to increase the life of the carbons failed in practice for one or more of the following causes: (a) Complication of the mechanism required for the purpose, (b) liability of the lamp to get out of order, (c) irregularity in the burning of the carbon, (d) screening the light, (e) expense of renewals.

Curiously enough, many years before the open arc came into industrial use investigators had attempted to prolong the life of the carbons by surrounding them by a globe closed air-tight or nearly so. Straite produced the first

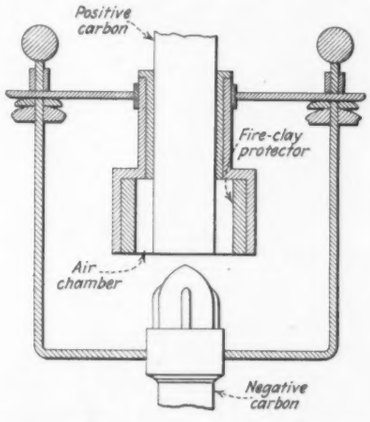


Fig. 4—Hardmuth Carbon Protector

experimental lamp of this kind in England in 1846. In 1878 Varley conceived the idea of using carbon powder to feed the arc in place of the carbon pencils hitherto used. (See Fig. 2.) He employed a stream of finely powdered graphite or carbon which was constantly renewed as the requirements of the light necessitated. The pulverized carbon was placed in a chamber or reservoir, provided at the lower end with a small orifice through which the powder was allowed to flow in a fine stream, like sand flowing in an hourglass. This stream of carbon impinged on two conducting poles, between which the arc was produced.

Varley found that unless the carbon reservoir was subjected to vibration, the powder, caking under the influence of the intense heat of the arc, quickly clogged the orifice. To overcome this difficulty he provided the lamp with a trembling hammer such as is commonly used in electric bells. The whole apparatus was inclosed in an air-tight case.

Many Experiments Made

From 1878 to the early '90s a host of experimenters in different parts of the world attacked the problem of prolonging the life of the carbons by excluding air from the arc. So far as the records go, these experiments resulted in failure mainly because of (a) flickering and unsteadiness of the light; (b) rapid blackening of the inclosing globe and obscuration of light. Many instances are also cited of the bursting of globes due to explosion of the contained gases.

Some of the earlier experimenters were handicapped by impure carbons, but satisfactory carbons were on the market for some years prior to the invention of the inclosed-arc lamp of commerce. (See Fig. 3.) The real secret of the invention lay not in improving the carbon but in operating the arc on an entirely new principle. The usual practice was to operate arcs with a current of 10 amp. and 45 volts at the arc. These figures became standards for the arc. The new invention was made possible by the discovery that when an arc is inclosed in a small globe having a suitably restricted and suitably regulated air inlet a long arc of abnormal voltage may be steadily maintained by a small current—a condition impossible in free or open arcs. This discovery was followed up by the construction of a lamp that would strike a long arc and that would also maintain it under proper conditions. The voltage of this type of arc was usually 80 and the current 5 amp.

Though the first commercial arc lamps of this type were put upon the market in 1894, it was not until a few years later that the great advantages of the inclosed arc over the old open arc began to receive general recognition. A pair of carbons, which in the open-arc lamp would burn only seven or eight hours, would last 150 hours in the inclosed-arc lamp. The open-arc lamp was addicted to hissing, sputtering and flaming, resulting in marked unsteadiness of the light and annoying shadows; the inclosed arc, on the other hand, gave a very steady light, well diffused and well distributed.

From the standpoint of lumens emitted per watt expended, the inclosed arc was never a competitor of the old open arc, yet even with this handicap the inclosed arc not only drove the open arc from almost all the commercial electric light circuits in the United States, but also enormously extended the field of arc lighting both in street lighting and in interior lighting. By the year 1908 upward of a million inclosed-arc lamps were in use in this country. This is the high-water mark of arc lighting in the United States. With the advent of the improved magnetite-arc lamp and the tungsten incandescent lamp, the inclosed arc lost its *raison d'être* and gradually disappeared from the lighting field.

Spectacular Effects Secured by Floodlighting

Illumination of the Capitol at Washington, of the American and Canadian Falls at Niagara and of the Panama-Pacific International Exposition at San Francisco

Evolution of Spectacular Illumination

From the gas-jet display in business streets of Philadelphia in 1876 to the gorgeous electrical effects of recent years—Steady advance recorded from exposition to exposition

By Walter D'Arcy Ryan

Director Illuminating Engineering Laboratory
General Electric Company

EPOCHS in the evolution of spectacular illumination are marked by the expositions of the past fifty years. The first attempt to provide night entertainment for exposition visitors was at Philadelphia in 1876. The Centennial Exposition itself closed down at sundown, but the merchants of the city banded together in an effort to carry the carnival spirit into the night. The buildings in the main portion of the city were outlined by thousands of gas jets, and on special nights there were large displays of fireworks.

Two cases of decorative lighting not very long after this which deserve special mention were the illumination of the Turkish Pavilion on Manhattan Beach, Long Island, in 1881, and of Elbridge T. Gerry's yacht *Electra* in 1883. On the dome of the Turkish Pavilion gas jets inclosed in colored bulbs were spaced on 1-ft. centers. Two hundred incandescent lamps on 2-ft centers were festooned between the masts and rigging of the *Electra*.

The first exposition that kept open successfully in the evenings was the Electrical Exposition in Paris in 1881. It was here that incandescent lighting was first shown to any extent. Arc lighting was also indulged in commercially, 1,350 hp. being used to operate 1,383 arc lamps.

The Mechanics' Fair held in Boston shortly after this period was notable because the entire lighting consisted of 1,500 incandescent lamps, the largest installation up to that time.

Exit Gas for Exposition Lighting

The first exposition in this country where electricity played an important part was held at Louisville in 1883. The lighting of the main building was done by the Edison Company with 3,998 lamps. A total of 7,000 16-cp. lamps were operated from fourteen generators running in parallel. This was the first exposition that gradually brought up the lighting from zero to full candlepower. The gas companies competed for the lighting with estimates of between 2,000 and 7,000 jets. This was the last exposition in this country where gas was at all considered in the plans for the main portion of the illumination.

During 1884 there were three expositions in this country that helped to make lighting history. Various forms of lighting were used at the Electrical Exposition in Philadelphia. At the St. Louis Exposition more than 5,000 incandescent lamps were used. This was the first installation to have the modern system of distribution and control from cabinet boxes. Knife switches were used here for the first time. All the feeders were of bare copper wire. The largest exposition of the period was the New Orleans Cotton Centennial. The main building here covered 28.7 acres, said to have been the largest building ever erected. Contracts were awarded to the Edison Company, the Louisiana Electric Company, the Fort Wayne Jenney Company and the Brush Electric Company. A total of 1,500 arc lamps and 5,000 incandescent lamps were employed. The illumination was brought on gradually. Expositions of the next few years did not use electricity extensively.

Ryan Electric Steam Scintillator and Fireworks, Panama-Pacific International Exposition, San Francisco, Cal., 1915

The third Universal Exposition, which opened in Paris in 1899, used electricity in several of the large buildings that were open to the public at night. Gas was used principally for outdoor lighting. On special fête days probably several hundred thousand gasjets were burning.

It was in the Court of Honor at Chicago in 1893 that we see outline lighting with incandescent lamps used for

the first time on an extensive scale. More than 8,000 of them were used for outline work in this court. The most spectacular lighting feature of the exposition was the two electric fountains designed by Luther Stieninger and installed by the General Electric Company. In connection with the display lighting of the exposition seven searchlights, two of which were 60 in. in diameter, were used.

At the Midwinter Fair at San Francisco in 1894 the cornices of the buildings in the main court were outlined with 2,250 incandescent lamps. The electric tower was 200 ft. high and had more than 3,000 incandescent lamps, mostly in color.

The Cotton States Exposition at Atlanta in 1895 employed about 5,000 incandescent lamps for outlining the buildings. Arc lamps suspended from hollow wooden poles were used for general exterior lighting.

Industries Tower of the Brazilian Centennial International Exposition, 1922

The first complete scheme of decorative and ground lighting by incandescent lamps was seen at Omaha in 1898. There were 21,000 8-cp. and 16-cp. lamps used in outlining the grand court. The general illumination for this court was provided with 309 posts, with from twelve to twenty 8-cp. lamps on each.

At Paris in 1900 there was a mixture of all types of illuminants with the incandescents predominating, a total of 76,720 being used for decorative purposes. The main part of the decorative lighting was on the Champs de Mars, and the climax of this was the façade of the Electricity Building and the Chateau d'Eau directly in front of it.

The greatest advance and most extensive application of incandescent lamps for decorative illumination was seen at Buffalo in 1901. Cost alone will probably prohibit more lavish displays of this type of lighting in the future. The lighting of the grounds was accomplished by 800 posts with from twelve to twenty-six 8-cp. lamps on the smaller posts and fifty-nine on the large structural ones. About the Court of Fountains there were more than 100,000 8-cp. lamps used in emphasizing the architectural lines of the buildings. The culmination of this vista of light was the 350-ft. electric tower studded with 11,400 lamps. One hundred searchlights were used in connection with the fountains in the main basin at the foot of the tower. There was also an electric fountain on a built-up island in North Bay.

Owing to the immense proportions of the St. Louis Exposition in 1904, it was impossible to duplicate the ideas carried out at Buffalo, so it was necessary to spread out the lighting to a certain extent and accentuate certain prominent features. The main picture of the exposition embraced the Grand Basin, Plaza of St. Louis, Festival Hall, Colonnade of States, the Electricity, Education, Manufactures and Varied Industries Buildings. These were all lavishly festooned with lamps. Each lighting unit along the colonnade had three lamps—white, emerald and amythest, each color on a separate circuit. Water rheostats were used for dimming each color. A total of 142,000 8-cp. lamps consuming 5,000 kw. were used for the decorative lighting on the exterior of the buildings.

The General Electric Company got the contract for 300,000 8-cp. lamps at 12.6 cents each. Outdoor lighting in general was by twenty-four 8-cp. light standards. Around the Grand Basin sixty 8-cp. lamps were used on each post. All the lamps for decorative purposes were brought up to candlepower gradually by means of water rheostats. The monumental features of the exposition were the cascades descending the slope between Festival Hall and the Grand Basin, in the illumination of which 20,000 8-cp. lamps were used. The night effect at the exposition was aided by a number of searchlamps placed on the roofs of the buildings. There were fireworks displays several nights of each week, with large displays on special days.

There were 100,000 lamps consuming 400 kw. used in the illumination of the Lewis & Clark Centennial at Portland, Ore., in 1905. Not an arc lamp was on the grounds. Seventy thousand of the incandescents were of 8-cp., all frosted carbon lamps for decorative lighting.

At Jamestown, Va., in 1907 the decorative lighting of the buildings was done with 8-cp. lamps placed on approximately 12-in. centers. A water rheostat of 2,500 kw. capacity was used to build up the lighting. Four minutes were allowed for lamps to reach normal candlepower. Projectors on steel towers played on the basins in the courts. One of the night pictures was the Administration Building, with the searchlight beams forming a fan behind the dome.

Two notable achievements in the field of display illumination that deserve special mention were the illumination of Niagara Falls in 1907 and the illumination of the Hudson-Fulton Celebration in New York in 1908. For the first time searchlamps were used extensively to bring about effects never before attempted. The feature of the Hudson-Fulton celebration was the Ryan electrical steam color scintillator.

One of the better examples of outline lighting as it should be employed in the illumination of expositions was shown at the Alaska-Yukon Pacific Exposition in Seattle in 1909. A total of 250,000 lamps were used here for all purposes. For decorative illumination the exposition used approximately 100,000 8-cp. all-frosted carbon lamps.

Panama-Pacific Relied on Its Illumination

The illumination of the Panama-Pacific International Exposition at San Francisco in 1915 marked another epoch in spectacular lighting. It was here that for the first time floodlighting of building façades, towers, statuary and flags was extensively used. All light sources were concealed or appeared as decorations, usually in colors and at low brilliancies. Other attractive innovations were the "Novagem jewel" and the use of colored light to relieve shadows of their harshness. It was the general consensus of opinion that the greatest contributing factor to the success of the exposition was the illumination. Millions came through the gates after the exhibit palaces had closed

for the night to see this lighting and the scintillator and fireworks displays.

The illumination of the Brazilian Centennial at Rio de Janeiro in 1922 was in many respects similar to the lighting of the San Francisco Exposition. The light sources, however, were often treated in color and used as decorations.

The attractiveness and drawing power of spectacular lighting are generally recognized. Rarely is there now an exhibition or show of any kind that does not stress its lighting features in all advertising. The illumination of the electric shows at Chicago and at Buffalo in 1919 are excellent examples of this class of spectacular lighting. The jeweled electric fountain was successfully used at the Pittsburgh Electric Show in 1922 and at the New York Silver Jubilee in 1923. Spectacular lighting when carefully planned does much to make the public as a whole realize the possibilities of both light and electricity. When fostered by the central-station company it becomes a promoter of good will. In fact, spectacular lighting might be termed the greatest agency for effective commercial and good-will advertising of the entire electrical industry.

The Incandescent Lamp

Electric lighting, at first a business, soon became a service and a factor in the world's civilization—Technique of relations between the public, the central-station companies and the manufacturers

By S. E. Doane

Chief Engineer National Lamp Works of General Electric Company

THIRTY-EIGHT years ago few, if any, of my associates thought of electricity or of electric lighting as being a factor in the world's civilization. We thought of it as a business. It does not seem so long ago since I first heard of one of these companies which make a business of manufacturing and selling electricity being called an electric utility company or electric service company, or carrying some name to indicate that it had a duty toward the public. It was distinctly a new perception of the electrical relation to the community. Up to that time our effort had been merely to plan electric systems, to shape and to use materials to produce apparatus and to distribute electricity. With the larger appreciation we began to see that there was more at stake than merely the making of lamps and the generating and transmitting of current to lamps and other loads.

In thinking of this time from the standpoint of the public I think it may be considered that with the dawning perception of larger responsibility came the end of our introductory period and the beginning of the period when our service to the community attained to sufficient magnitude to attract general attention. The lamp itself has been improved tremendously. A lamp of the ordinary size will give six times as much light as the first incandescent lamp put upon the market, without using any more energy. How this has contributed to lower costs and greater consumption is evidenced by the fact that whereas in 1880 the candle-hours used annually per family of population were only 50,000, in 1923 they had risen to 800,000.

Ideals of the Lamp Makers

As distinguished from this material progress of the lamp, I wish to discuss some of the ideals which have guided the lamp makers in contributing their share to the mosaic of electrical progress. The two things which the public purchases again and again in the production of electric light are electrical energy and incandescent lamps. All the other materials are of a relatively permanent character and form part of the installation. Lamps are in the nature of supplies which are continuously consumed and must be purchased regularly.

The incandescent-lamp men, awakening to their responsibility, found themselves heirs to a situation of great complexity. The electric lighting customer had little knowledge of what he needed, and even if he was skilled, the complexity of stocks, having lamps of many voltages, lamps with many kinds of bases, and rated in terms of non-standard value, was a sufficient problem in itself. There was frequently more than one plant in the city, these plants having different voltages. There was almost a total lack of standardization in fittings for holding shades, and from a lighting standpoint most of these shades were of poor character. It can be seen that this combination of circumstances made it look like an almost hopeless task to bring order out of this chaos.

It seemed to us that we lamp men must be the major clarifying influence, as the central-station men had a burden of responsibility which was very great and sufficient to engross their attention and must necessarily work through more difficult channels of influence, since each station was limited geographically, whereas we as manufacturers reached all parts of the country. Conditions quite as bad exist in many places in Europe today, where none of the influences which have brought about the march of progress in America have been operative.

As best we could, we endeavored to view our problem from the viewpoint of the consumer who knew little about electrical matters and endeavored so to simplify that portion of the industry which we accepted as our responsibility, that the user of electric light, without special knowledge on his part, would still purchase the lamp he needed to give him the best service.

The central-station companies during all this period have not only developed their physical equipment and eliminated annoying interruptions of service, but they also have spent vast time and effort making it easy for the customer to buy electricity. Between the central station on one side and the lamp manufacturers on the other there has been developed a community technique by which

a great industry of service has been organized, in the course of which energy and lamps have been intelligently co-ordinated.

The big conception which Edison, Thomson, Brush, Swan, Weston, Maxim and many others developed in earlier days has existed without change up to the present day. The new development since this early period has been the development of the technique of relations between the parts to its growth, namely, the public, the public utility companies and the manufacturers of incandescent lamps. It was necessary for us to develop some theoretical objectives and to make plans which over a long period of years would gradually attain these objectives. How well we have succeeded is worldwide knowledge. The reason is not generally understood. Our objective was threefold: (1) The customer must have at least the irreducible minimum amount of knowledge of the use of light. (2) He must be able to procure easily, quickly and cheaply lamps which he needs. (3) There must be available proper accessories by which this lamp can be placed upon a circuit and give light, and this light when developed must suit his needs. It is obvious that these things are all independent of the efficiency of generation of current or of the system by which electricity is turned into light.

Major Accomplishments

Under the above three headings the major accomplishments in the lamp industry can be listed as follows:

The dissemination of lighting knowledge to the trade and through them to the public, or direct to the public, has been accomplished by several methods and through various channels. Fundamentally, the course of progress and new developments in lighting, as related to the engineering features at least, has been charted largely by manufacturers' educational publications and published laboratory reports. These publications were initiated and kept free from commercial bias; the contents were dependable engineering facts. Consequently, they earned a place alongside, if not ahead of, accredited texts. They were guideposts along the path of lighting progress which technical schools, engineers, central-station companies and the trades felt safe in following.

In later years especially, visual education in the form of well-planned demonstrations has become, as a supplement to the printed word, a tremendously effective method of portraying lighting development and promoting lighting education. As the seed of orderly educational development has thus found root, it has grown and spread until its branches extend in countless directions.

The various national societies have done notable work in the dissemination of lighting knowledge. The Illuminating Engineering Society is a national society deserving special mention in this connection. It has prepared lighting instruction for schools and colleges and has promulgated codes of lighting for factories, for city streets and for automobile practice to which in many cases the weight of authority of law has been given.

The National Electric Light Association has also disseminated a vast amount of information on lighting along similar lines, also through papers and exhibits at its annual conventions. The respective associations of the jobbers and contractor-dealers have broadcast to the public many things relating to lighting.

The lamp manufacturer has made it possible for the public to obtain its lamps easily, quickly and cheaply by (a) standardization of the lamps, and (b) making them available everywhere. The lamp business is one of the most highly standardized industries in this country, which leads the world in this respect.

As recently as the year 1900 lamps for ordinary lighting service in the United States were supplied with thirteen different types of bases and many types of construction—shapes of bulbs, forms of filament, etc. Lamp voltages commonly in use ranged by single-volt steps from 100 to 130, and the result was that a manufacturer could daily expect to receive orders for one or more of fifty-five thousand varieties of lamps. At the present time there is one standard type of base—medium screw for small-sized lamps and "mogul" screw for large lamps. For any one type of service there is only one standard shape of bulb and filament. There are some varieties of bulb finish—frosted, colored, etc. There are only three voltages of supply—110, 115, 120—and the industry is committed to the elimination of two of these, which will still further simplify the industry and thus enable the consumer to procure more easily, quickly and cheaply the lamps which he needs.

The result of these standardizations is that there are at present only about 160 types of lamps which are commonly used for general lighting. This simplification means much in the reduction of expense and improvement in service.

The commercial distribution of incandescent lamps is by means of the agency plan which minimizes costs, facilitates supply of lamps of proper voltage and maintains the nearest possible to a direct contact between manufacturer and the public.

Advantageous Business Policies

Many of the business policies adopted by the lamp manufacturers have contributed to the cheapness of electric lighting. As an example, I will mention the policy adopted during the time when "Mazda" lamps were replacing the old carbon lamps. I speak of the policy of advertising three times the light for the same cost rather than the same light for one-third of the cost. The latter would have been true only temporarily. The cost of supplying electricity to the small user is so greatly a question of overhead costs that the possibility of low rates depends very largely upon having a good volume of sales. If the change-over from carbon to tungsten lamps had been made on a candlepower basis rather than on a wattage basis, the demand for electric light would have been very greatly obstructed, with a resultant effect of much higher unit energy costs and a reduction in our standard of lighting.

The "RLM" standard line of reflectors is an outstanding example of another class of effort whereby all manufacturers of metal reflectors have accepted the same standard designs and worked to a standard of quality maintained by an independent testing agency. Standardization of reflectors would be of no avail were it not for the accompanying standardization of sockets, shades, holders, etc. This has resulted in accomplishing all parts of our threefold objective which was set up as a guide as far as general industrial lighting is concerned and has made matters simpler for all industry as well as manufacturers of this type of equipment.

There are many activities of the lamp manufacturers which are of a general nature and cannot be classified under any one of these three headings, such as the collaboration of the personnel of the manufacturers with representative central stations and other bodies in committee work in national societies.

Space limitations do not permit adequate reference of all which has been done along the lines I have chosen for my article. What I have written is rather typical and indicative.

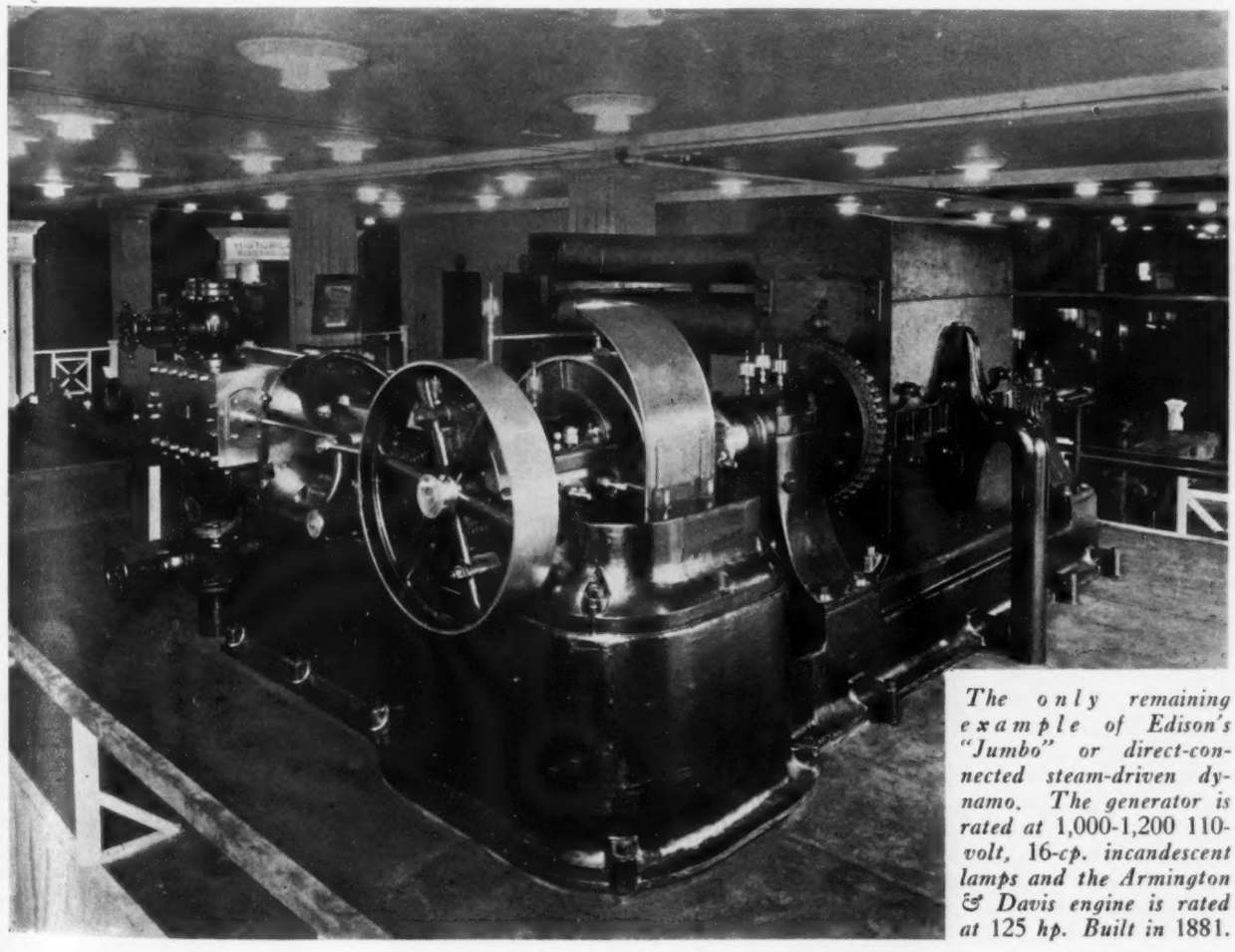
The Edison of 1879

Retrospective glance at the days when the invention that was to revolutionize the material world was being slowly brought to perfection at Menlo Park

By Francis Jehl
Edison Pioneer

REMINISCENCES of the surviving pioneers of electric lighting have much of the fascination of a romance by Jules Verne, for Edison's conceptions seemed superimaginative at first. When they turned out true and practical it was to the embarrassing astonishment of scholastic men who thought that they alone had the knowledge necessary to solve the difficult scientific problems of those days. Edison's genius and manner of research work created a new epoch, the Edisonian age. The history of modern electric lighting and distribution dates from 1878, when he formulated the essential requirements for an electric central station. His ideas were met with incredulity. Sylvanus P. Thompson was speaking for many scientists besides himself when he asked: "When we spend heat and motive power to produce our electric currents (and know of no cheaper way of producing them) do you imagine that we shall get out of our electricity more heat or motive power than we put into it?"

There was one man who knew better, and he was the self-tutored electrician Thomas A. Edison, who had studied in the hard-boiled "university of life" and who with his indomitable will and spirit had pledged himself to solve the great problem that a host of investigators before him had failed to solve. At Menlo Park he began a methodical study first of the rare and high fusible metals, and in many arduous weeks of day and night toil he succeeded in producing a metal lamp that was more durable and gave more intensity in light than had ever been produced before. However, Edison was con-



The only remaining example of Edison's "Jumbo" or direct-connected steam-driven dynamo. The generator is rated at 1,000-1,200 110-*volt,* 16-*cp. incandescent lamps and the Armington & Davis engine is rated at* 125 *hp. Built in* 1881.

vinced that with the metals then at his command he could not make a practical lamp. It was in the early part of 1879 that he exhibited the results of his researches on platinum and iridium lamps for the benefit of his financial backers. In his machine shop he installed six or eight such lamps supplied with current from a Gramme dynamo machine.

His work on platinum and iridium was productive of a great discovery, for he found that metals as well as other substances were packed with gases. If such a metal

Edison Automatic Voltage Regulator. The Relays Operate Pawls and Ratchet Wheels, Cutting Resistance In and Out of the Shunt Field

or other substance be placed in a vacuum and then be subjected to the action of an electric current, the heat expels the gases, which in turn create air washings that are with the gases doubly detrimental to the hot conductor. Edison found that the occluded gases could all be driven out by an intermittent process of heating and evacuating. This discovery was one of the things that led to the creation of his incandescent carbon-filament lamp of high resistance.

Experimenting with Carbon

When Edison began to take up carbon again as the material from which he intended to construct a practical lamp he found that in order to conduct his experiments properly he would need an artificer who could manipulate glass. One was engaged, Sprengel and Geissler vacuum pumps were made, and Edison began again his experiments in electric light, which were all conducted on the upper floor of the laboratory. There the inventor could be seen day and night working with three or four assistants. The work was generally carried on at the sink and in front of a long, low wooden case that contained the battery salts and other dry chemicals, its top being used as a table. Here hundreds of hydrocarbon compounds were mixed and made into putty of various grades and then rolled out into threads between two small flat boards. Edison himself would take them downstairs and carbonize them in furnaces procured for that special purpose, trusting no person but himself to carry out this work.

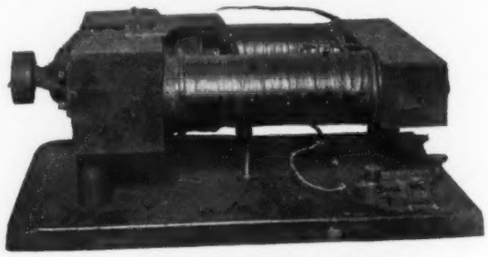
The first carbon filament that Edison made broke when it was attempted to connect it to the leading-in wires. The first few trials were made by forcing the ends of the platinum leading-in wires of the glass stem into tiny carbon cups and by inserting the carbon filament in the cavity, which was then plugged up with powdered carbon or paste. The first lamp finished in this manner was evacuated on a Sprengel pump after having been treated for about eight hours in order to expel all the occluded gases. This lamp had a short life, and it was noticed that a sort of sparking occurred sometimes at the legs of the filament, due to bad contact. In addition to Edison and the young man who operated the vacuum pump, there were only two other assistants present to witness the first carbon-filament lamp experiment in 1879. After Edison had tried several lamps constructed in this manner he made some that had a spiral-formed filament and carbonized them together with small pieces of platinum wires that were held at the ends of their legs by binding them with a carbon paste. These spiral filaments were then connected to the leading-in wires by means of small brass connection pieces that held both the leading-in wires as well as the short platinum ones connected to the filament by the carbonized paste joints.

Early Lamps Burn Twenty Hours

Some of these lamps, which all had a high resistance and small radiating surface, had a life of more than twenty hours. It is a pity that none of them was ever preserved. After they gave out they were broken up and the platinum was retrieved. Edison then tried numerous other experiments with all manner of materials, even using human hair taken from the red whiskers of a visitor. He tried all kinds of vegetable fibers, papers and threads, many of his experiments giving promising results. It was while using different kinds of silk and cotton threads that the thought struck him that perhaps the Clark thread mills at Newark might furnish him with a special brand that would give better results. This was in October, 1879, and a few days afterward he procured a package from the Clark mills containing a pound of white thread. New experiments were carried out, and about the middle of October Edison was satisfied that he had reached a point at which his carbon filaments could be considered stable and that the practical and commercial incandescent lamp was born. Not long after he made his successful Bristol cardboard lamps and used platinum clamps for holding the filament. He gave his famous public demonstration in December, 1879, during which some of the dwellings at Menlo Park were lighted up, receiving their current from the machine shop by means of overhead wires.

Regenerating the Dynamo

During the period that Edison was conducting his epoch-making researches in connection with the incandescent lamp he also regenerated the art of dynamo construction. He knew that the Franklin Institute had tested some of the well-known dynamos of that period



One of Edison's Earliest 100-*Volt Shunt-Wound Motors*

and had found that the best of them all had given an efficiency of only 40 per cent. He was well aware that with such a loss in the conversion of power his conceptions regarding the commercial distribution of electricity might prove impracticable. He procured the two dynamos that offered the lowest and highest results and made a thorough examination and study of them and was not long in discovering their principal defects and where most of the power was wasted.

He then, with his mathematician, laid out a series of long and exhaustive experiments in order to determine certain electrical and magnetic data that had never before been investigated. It must not be forgotten that at this period electricity was in its infancy and that what was done with it in a practical way was effected mainly by practical men. It is true that there were many long and conflicting methematical treatises on the subject that were hardly understood by the writers themselves, but the sublime law of George Simon Ohm was not appreciated and little was understood regarding its application to electric lighting. Even the Foucault experiment that was demonstrated in almost every college was hardly ever noticed by the dynamo constructors and their scientific advisers in those days, and numerous documentary evidences plainly verify the lack of scientific judgment employed in the construction of most of the dynamos prior to Edison's machine.

Many of those early machines had only solid-iron cores in their rotating parts, and even as late as 1881 one well-known designer constructed his drum armature with a hollow cast-iron piece through which, by means of a hole bored into the shaft, he led water for cooling purposes. The detrimental effect of bad magnetic contact, insufficient cross-section and injudicious winding of the armature, as well as the field magnets, was not even noticed, and thus Edison found it necessary to probe into unwritten laws and obtain by experiment the facts upon which he built his dynamo machine, which when finished gave an efficiency of 90 per cent against 40 per cent.

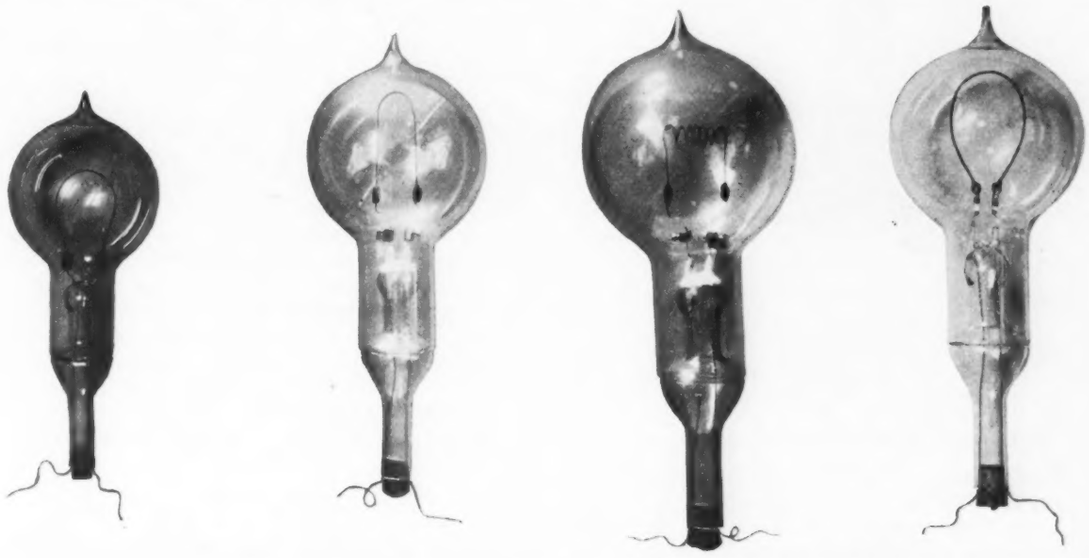
The great importance of this achievement can never be overestimated, for it established salient principles that later on furnished many theorists with ample material and data from which they filled the books and journals of those days. The same may be said concerning the method of ratio which Edison's common sense dictated when he wound his armature with a resistance as low as it was possible to obtain and that was compatible with the generation of pressure. Here, too, scientists began to decry Edison, accusing him of understanding nothing of electrical laws; but he had outwitted them all by discovering primary facts that could never have been attained by slinging Bessel's functions about. Edison never worked with suppositions; he always dug down to the rock bottom and there built his foundations.

In 1879 Edison's foresight also devised that simple and ingenious appliance known as the safety fuse, which is still in use in every part of the world where electricity is generated. No other device has yet been able to supplant that safeguard of life and property and canonized pet of the underwriters. In the same year he constructed his first electrolytic meter, containing the essentials of the one that was used by the Edison companies for over a decade before the efforts of others could replace it by a reliable electromechanical one.

Edison Had No Prompter

In summing up what Edison did when he created a system of electric lighting, one might simply quote what Preece said in reference to the Edison exhibit in Paris in 1881: "Nothing seems to have been forgotten, no detail missed." Many entertain the most erroneous impression that Edison was surrounded at the time when he invented the incandescent lamp and the high-efficiency dynamo by a large staff of well-drilled assistants and that some of them played the rôle of prompter. In the gigantic problems before him he naturally required help—help similar to that which the architect needs when he has finished the plans of his building and begins its erection. Who built the building—the architect or the men who piled the material according to his plans?

When Edison conducted those epoch-making researches which revolutionized the world he had six laboratory assistants who carried out the experiments under his direction and supervision. Each of these men had a laboratory notebook in which he noted the progress of the work to which he was assigned. When contrivances or apparatus were needed in the course of experimenting, they were made and furnished by the men of the machine shop, among whom were some clever mechanicians, who carried out their orders under the control of the master mechanician, one of the six above-mentioned assistants. The men at the laboratory were paid a fixed salary; in



The Hydrocarbon Paste, Vegetable Fiber, Spiral Thread and Famous Paper or Cardboard Filament Incandescent Lamps of Edison

the machine shop overtime was paid. Edison had, besides, two men who worked upon other things, principally testing the grade of ore from California. Toward the end of 1879 some men were engaged to familiarize themselves with the Edison motograph telephone before they were sent to England to introduce it there. At the office there were four men and a draftsman who attended to

Original Edison "Z" 110-Volt Bi-Polar Shunt-Wound Dynamo Rated at 16-Cp. Lamp Coils.

The Cord Winding on the Fields Is Modern and the Switch Contacts Are Incorrect.

the business transactions and the making of the patent drawings. Such was the small group that aided the great master in his work of 1879 with all the enthusiasm and devotion possible. From him alone came the initiative and impulse.*

Edison's Famous Graduates

The Edison laboratories at Newark and Menlo Park, together with the first office of the Edison Electric Light Company at 65 Fifth Avenue, New York, and the Edison Machine Works at Goerck Street in the same city, were not only the starting place but the Alma Mater of many successful Edison pioneers. When the great master sent them out into the world the knowledge that he had imparted to them was the baton that they carried in their knapsacks. They all did their tasks to the best of their abilities, some being more and others less endowed with those intensive traits that characterize the "live-wire" man. A few have attained extraordinary prominence as directors of the largest electrical concerns of the world; some are still and others have been the prime movers in their profession—the field marshals of applied electricity.

Taken collectively, these young pioneers were men of great potentialties, talented, super-energetic and endowed with intellectual powers that enabled them to progress rapidly to positions of eminence where they became the guardians of enormous capital investments. They possessed the same qualities of initiative that characterize all leaders and were broad-minded, far-visioned and ever ready in emergencies, while at the same time they became master experts in all the phases of administration as well as of operation. As organizers they became in the economic world revolutionists of the first order and have built up temples of production the magnitude and utility of which are far beyond any dreams they themselves ever had when they first entered the ranks as soldiers in the Edisonian army.

The healthy, vigorous and progressive mentality of these men of the old Edison corps needs no further comment. Their names suffice. They have all been self-made men who have reaped the legitimate reward of their supernormal qualifications. A list of seven men who from Edison's workshop rose to high places in the industrial engineering world comprises:

SIGMUND BERGMANN
President Bergmann Electrical Works, Berlin.

SIGMUND SCHUCKERT
of the Siemens-Schuckert Works, Berlin, Vienna and Budapest.

LOUIS RAU
of the French Edison Company, Paris.

EMIL RATHENAU
of the German Edison Company, now the Allgemeine Elektricitäts-Gesellschaft, Berlin.

JOHN W. LIEB
Vice-President New York Edison Company.

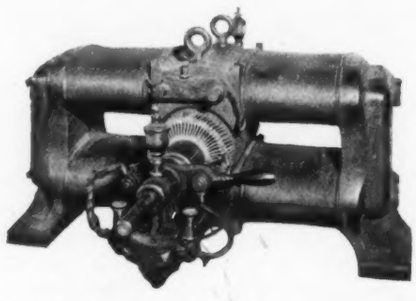
SAMUEL INSULL
President Commonwealth Edison Company, Chicago.

CHARLES L. EDGAR
President Edison Illuminating Company of Boston.

Schuckert, Rau and Rathenau are dead. Sigmund Bergmann and the three Americans still live, and each of them has been constantly "on the same job" ever since applied electricity obtained its footing. Today they are more active than ever. Thousands upon thousands depend upon their guidance, and their productive work has contributed tremendously to the welfare of the public.

*Recently the writer spoke with a gentleman who was commissioned by the United States government to study the organization of the Edison industries at West Orange, N. J. He relates that when he spoke to Edison upon the subject, the latter inquired "What organization? I am the organization." That's the same Edison of 1879.

Original "Sprague" 5-Hp., 220-Volt Compound-Wound Direct-Current Motor



"Weston" 5-Kw., 110-Volt Direct-Current Shunt-Wound Dynamo of 1885

Research

Twenty-five Years Ago and Now

Electrical advance closely interwoven with that of chemistry and physics — Research that survives will not be separated from the uses of the people—Need for publication of the results obtained

By W. R. Whitney

Director Research Laboratory, General Electric Company

TO ME the past twenty-five years are but a typical part of the past two hundred and fifty thousand. The trend is the same in both. There has always been steady improvement, perhaps some small catastrophes. After the crude stone chip came the flint arrow, after the flint the bronze, after bronze the steel. After the crude picture came the writing, and after the writing came printing. Now comes broadcasting. The general trend is upward.

In comparing research of twenty-five years ago with that of today we probably overestimate recent advances. We cannot divest ourselves of our local measuring rods and we have no calibrating correction in absolute units. We know the stone-chip age was infinitely longer than the flint-arrow age, and this in turn longer than the bronze age, so we think we are speeding up. Certainly the world has always been seeking new things, and the discovery of working flint was as much of an education and as nearly a catastrophe as working iron or making gunpowder. The truth is that we are still terribly ignorant and use tools destructively. We merely seem headed right when we are actively seeking truth instead of idleness.

Perhaps some of our non-experimentative academic thinkers are still looking backward, but forward-looking physicists are seeking the relation between matter and energy, or the connections of time and space, and, because of their experiments, much will be found that is new and useful.

In this quarter century new facts were discovered in so many parts of knowledge that even the names of the divisions disturb us. Only an "ologist" can keep track of the new "ologies." Within our period cytology has analyzed heredity into individual parts of ultramicroscopic strings of beads (they call them genes). These are parts of what was formerly the ultimate thing, the nucleus of the still earlier smallest conceivable organic unit, the cell. Today each invisible chromosome bead carries a full Pandora box of future characters. Moreover, the cytologist now sees that every living cell is an electric battery, and reflexes become conductivities. Therefore, when we recall how stationary has been the knowledge of primary and secondary batteries during this quarter century, we can but hope that through experiments on oxidation in protoplasm or absorption of sunlight in chlorophyl a new path in living electricity may be opened.

In this same period chemistry thought its units were atoms with which it built countless new structures, until new experiments showed that individual atoms actually resemble complex solar systems much more than simple similar solid spheres, and then chemistry took a new step.

Meanwhile physics and electricity, by simple trial, instead of by pure philosophy, found the active little electrons whose motions are electric currents and whose gregarious idiosyncrasies produce all matter. If this recent history could reach us through our dense egotism, it might show us that the novelty of learning is a normal, healthy state and that development is our main abiding asset. Directed motion seems the aim. Destination is not in sight. The urge to learn indicates that the future holds possibilities for which enormously expanded understanding will be necessary.

Within our quarter century J. J. Thomson, Rutherford, Aston and others have made a great reputation for research at Cambridge, and Townsend, Perkin, Bailey, Lambert and others are doing the like at Oxford. Meanwhile the type of research work inaugurated at Johns Hopkins has steadily spread over our country, so that hundreds of laboratories for experiment are now well established.

Naturally such work divides itself, as it progresses, among the different branches. New chemistry has spread its influences over many fields, and new physics has helped them all from electrical engineering to biology. For example, the new knowledge of X-rays quickly found itself used by the surgeon and the metallurgist. The student of heredity used it, and the student of pure electrical phenomena made it fit his recent pictures of "deceleration" of electrons. The pure physicist gets at the structure of the elements by its use, and the chemist makes it perform his analyses.

Among the peculiar penalties which still persist in pure research is the penury of publication. Only slightly has the condition changed in the past twenty-five years. Most of the fundamental research work is still done by successors of the poorly paid priests, and the members of the profession must gather funds to provide for printing their work. But there was a time when even this spread of research novelties would have been prohibited. So perhaps at some later time such help will be more readily forthcoming.

It is not easy to separate the purely electrical research work of the period from the physical and the chemical. In fact, nature recognizes no separation and we are slowly learning to follow her.

An interesting picture of growth in American research which shows the general trend is obtained from the

abstract work of the American Chemical Society. In 1913 there were abstracted 18,681 research articles in chemistry and allied fields in the world's scientific literature. At that time the United States contributed 21 per cent of the researches, Germany 35, Great Britain 15 and France 13 per cent. In 1923 there were practically the same number of researches (18,736), of which the United States contributed 32 per cent, Germany 27, Great Britain 15 and France 11 per cent.

The evidence of much further extension of scientific research in America is worth a review. There are now several hundred research laboratories connected with our industries, and our colleges are beginning to take the place among nations which is rightfully theirs in advancing pure science. Among the colleges which have built new chemical or physical laboratories, or are about to build new ones, are Harvard, Yale, Princeton, Columbia, Cornell, the Massachusetts and the California Institutes of Technology, the University of Buffalo, Dartmouth and Carnegie Institute. These probably much more than double the previous university facilities for research.

The National Research Council also signifies the trend of the times in America. This organization is gradually and intelligently finding its way in the promotion of research interests and has recently dedicated a fine new building for permanent quarters in Washington.

The Boundless Electrical Field

In our electrical field the developments seem almost unlimited. Labor-saving devices, for novel uses not even recognized as labor, crowd one another in our advertisements. But, what to us is much more interesting, about all the phenomena of the world are now being put into an electrical setting. Within the twenty-five-year period all matter has been constructed of positive and negative electric charges, all properties have become due to location, orientation or distribution of these charges. Life itself is becoming explicable as the actions of a lot of electromotive forces which here and there exert their characteristic pressures. The living cells of plant and animal, with their numerous assemblages constituting vital organs, seem to depend on the electric charges of their colloid particles for growth. The selective permeabilities of their living membranes to the various positive and negative ions of the body fluids supply electrical potential differences needed to explain the countless migration, diffusion, filtration, concentration and elimination processes which are peculiar to life and which long baffled the physiologist.

The last twenty-five years have seen a new concept of electricity. At first electromagnetic influence resembled light in using the same medium and moving with the same velocity. Cathode rays were then Crookes' unknown fourth state of matter whose impacts later produced rays called "X" because unknown. At about the same time new researches showed that a chemical element was decomposing and could not be stopped. It was breaking up into something like positive and negative electrical charges while at the same time producing most penetrating X-rays. In 1900 the electric arc seemed incomprehensibly complicated because both electrodes wasted away and yet either one could grow under certain conditions. Order was brought about through Thomson's conception and Millikan's demonstration of the electron. Now practically everything electrical or material is traced to the electron, and not only ordinary light, but cathode rays, X-rays, radium rays, wireless, vacuum arcs and vapor arcs have been brought into simple order. This has supplied an absolutely incalculable quantity of terrain for the future.

Thus in the field of electrical research the smallest thing, the electron, has become the greatest. No reduction in the rate of disclosure need be expected of things so fundamental. Many separate paths of research now branch from it. Perhaps high frequency is one of the most active at present. The high velocity of electrons at ordinary potentials, coupled with their recent availability from heated bodies, makes it possible to produce energetic alternating electrical currents at any conceivable frequency. Therefore we have to ask ourselves what service we may find fitting for this new advantage. There were reasons for twenty-five cycles and other reasons for sixty. What uses can now be made of twenty thousand or fifty million? Here is a field for new research which has no limits. The present application to non-interrupting wireless is but an entering wedge with which we shall probably learn the elements of energy and its economy at new frequencies.

Large research laboratories operated by commercial organizations, where pure or fundamental scientific work is encouraged and published, have developed within our review period. These are made possible by the magnitude and spread of our organized industries and by the close connection between knowledge and utility. They would probably have been impossible at any earlier period.

The General Electric Company's research laboratory was established just twenty-five years ago, and it is also little more than twenty-five years that many of our great manufacturing corporations have been developing. In virtually every industry (foods, coal, oil, steel, chemicals, electricity, traffic and communication), and in all civilized countries, good service dictated extensive and intensive efforts for greater amelioration, and so trusts were born. The urge in such undertakings grew less a one-man habit, a beneficence or an avarice, and became more a large group spirit for accomplishment.

While research laboratories were developing in different countries they were learning the principles of survival. It was found that a gulf separating the sciences of the schools from the uses of the people is unproductive, as is an exclusion of new knowledge from live industries. This was perhaps first recognized in the case of organic chemical syntheses, such as the production of medicaments and dyes. From "606" to the indigo blue of overalls, the world wanted them all.

Immediate forerunners had established science in the world's schools, and scientific research had slowly become part of American college education. As untried benefits accrued engineering schools appeared even where science had been anathema, and through it all there developed that faintly appreciated but well-organized complex, international scientific literature.

The real value of any research depends on the kind and number of its applications. Therefore publication of research data frequently served outside the narrow needs of the original work, and the process of contributing records to science persisted. If left buried in notebooks this would have marked the industrial scientist as unable to take his proper part in the advancement of knowledge. Perhaps publication was established in the electrical industry by the early letters of Franklin and America's first Philosophical Society, but, as Bacon and Gilbert, Davy and Faraday also published, priority is indeterminate. Thus, in turn also, the ELECTRICAL WORLD is but taking part in a development which twenty-five years ago was only dimly foreseen and is probably still underestimated.

Brief History of Frequency Selection and Standardization

Why 133 cycles, 125 cycles and other high frequencies were first adopted—How 60 cycles has taken the lead—Fight of American manufacturing companies' engineers for standards

By the late

B. G. Lamme

*Chief Engineer Westinghouse Electric & Manufacturing Company**

IT WOULD not be correct to say there has been a gradual evolution of a standard frequency in America, for at present there are two frequencies in quite general use, and, furthermore, these two were among the first brought forward in the change-over from the old 133 cycles. It is true that there has been a prolonged battle between these two for the ascendency, with victory leaning first in one direction and then in the other.

Let us review the history of the frequencies briefly. In 1886 and the following four years 133 cycles and 125 cycles were standard. The choice of a frequency such as 133 cycles may seem odd to those who do not know its derivation. In the beginning of the alternating current, about 1886, frequencies were not known in terms of cycles per second, but in alternations per minute. In the early design of the alternating system, with small house-to-house transformers, a high frequency was considered most desirable on account of the transformers. Consequently the frequency was made as high as the generator designs would bear. All alternators in those days were belted. One of the earliest Westinghouse designs was made with eight poles and was operated at 2,000 r.p.m., giving 16,000 alternations per minute, or 133 1/3 cycles per second under the present designation. The Thomson-Houston company made its designs for 15,000 alternations per minute, or 125 cycles per second. The Slattery system (Fort Wayne) was for 133 cycles, if the writer remembers correctly.

Discarding High-Frequency Service

As alternating-current service was mostly incandescent lighting, these high frequencies were satisfactory. Later, however, when other service came up for consideration, 133 cycles did not make a good showing. When the Westinghouse company took up the Tesla motor experimentally, in 1888-1889, it soon found two fundamental difficulties in the existing alternating-current systems, namely, the high frequency and the single phase. Successful polyphase motors were designed in 1889 and 1890, that is, they were successful on frequencies as low as 40 cycles to 60 cycles and on polyphase circuits, but neither of these was available commercially. Therefore, largely for these reasons, the development work on the Tesla motor was abandoned at that time as the handicap of introducing a new system along with the motor seemed insurmountable.

However, other conditions were attracting the attention of the engineers of the manufacturing companies. Alternating-current arc lighting was being tried at the existing high frequencies and was not proving satisfactory. Also, it was foreseen that if the alternating system was to develop much further, some method of drive other than belting would have to be adopted, such as direct coupling to the prime mover or direct drive (engine type).

L. B. Stillwell took up the subject, in its various phases, with the transformer and generator designers, the arc and incandescent people, etc., to determine the most suitable frequency for the future. There was much conflict of interests and opinions, and naturally some compromise was necessary. The transformer people wanted the frequency held fairly high. The generator people required a much lower frequency for direct drive. Many of the Corliss type of engines of that time operated at 80 r.p.m. to 90 r.p.m. At 133 cycles per second (16,000 alternations per minute), this meant a generator of 200 poles for 80 r.p.m., a quite prohibitive construction. The generator designers preferred about one-third of the existing frequency, with 60 cycles as about the upper limit. However, after most careful consideration and extended consultations, Mr. Stillwell selected 60 cycles as the best compromise, and this was put out by the Westinghouse company about 1890-91 on some belted machines, the engine-type or direct-coupled alternator not appearing on the American market until some two years later. This new frequency seemed acceptable and came into general use rapidly. Its adoption was accentuated some two years later when polyphase alternators for general purposes began to appear.

Commercializing the Induction Motor

About 1893, in a discussion in Mr. Westinghouse's office with his engineers, the question of how to commercialize the Tesla, or induction, motor came up. It was explained that the new frequency of 60 cycles was satisfactory but that no polyphase system was available. Some one suggested that a "fad" be made of the polyphase generator, so that when a lot of such machines had been installed throughout the country the sale of the induction

*This paper, written for the Semi-Centennial Number of the ELECTRICAL WORLD, was prepared by Mr. Lamme only a short time before his death on July 8 last.

motors would automatically follow. This was agreed to and orders were given to build as quickly as possible a line of belted polyphase alternators. This was done and the machines "took" very quickly. Orders were then given to get ready a line of induction motors of moderate sizes, but the demand for them came before they were ready for the market, and in some instances they were actually pulled out of the test room and shipped with only partial tests.

The General Electric Company apparently followed a somewhat similar general policy with its monocyclic system, in which, as far as the writer remembers, 60 cycles was used quite generally. The Stanley-Kelly system of polyphase alternators at first used 66 2/3 cycles as standard, but later used 60 cycles.

But the engineers were not altogether satisfied. They felt that means should be developed for converting alternating current into direct current in a simple, efficient manner, and even as early as 1892-3 had succeeded in doing this very well indeed by means of rotary converters, but at quite low frequencies, about 30 cycles. In fact, 60 cycles seemed out of consideration. Thus the rotary converter appeared feasible if only there were low enough frequency, and this soon came about in a rather curious way. In the plans for the first large Niagara electrification the engineers of the Niagara Falls Power Company designed a 3,750-kw. generator of 250 r.p.m. with eight poles, thus giving 2,000 alternations per minute (16 2/3 cycles per second). This choice of a very low frequency apparently was due to Professor Forbes, who felt that at this frequency commutator-type alternating-current motors could be run. Evidently he had but little knowledge of or faith in the polyphase induction motor, and apparently the rotary converter was not considered at all.

When the designs of the power company engineers were submitted to the manufacturers, the Westinghouse company proposed as an alternative a sixteen-pole, 250-r.p.m. machine giving 33 1/3 cycles. This was claimed to be much superior from the induction-motor and rotary-converter standpoints, and it was argued that these were coming types of apparatus. There was much discussion of these two proposed frequencies. Along with the arguments brought forward by the Westinghouse engineers, they showed an actual rotary running on 3,400 alternations (28 cycles). This was more or less convincing.

During the discussion of the general subject some one suggested, as a compromise between the proposed eight-pole and sixteen-pole machines, a twelve-pole generator at 250 r.p.m., thus giving 25 cycles. This was finally adopted, and it apparently was the beginning of the 25-cycle frequency. Not long afterward a number of engine-type generators for Edison stations used this frequency, it being considered well suited for parallel operation of such generators. Parallel operation was at that time recognized as a coming practice, and it actually was practiced as early as 1894-95 on 25-cycle direct-coupled generators in the then new East Pittsburgh plant of the Westinghouse company.

The use of 25 cycles grew rapidly, especially when rotary-converter substations proved to be successful in producing direct current for electric railways and for Edison systems. By 1898-1900 it led 60 cycles in the total capacity of apparatus sold, although possibly not in the number of units. But the average 25-cycle generator unit was of much greater capacity.

By 1905 it began to look as if the 25-cycle frequency would ultimately drive 60 cycles out of business, except as an auxiliary, and it was common talk that lighting would be done through 25-60-cycle frequency changers. The steel-mill engineers adopted 25 cycles as their standard, partly on account of the large low-speed induction motors required in such service and partly on account of rotary converters. Under the circumstances the choice they made was the only possible one at that time.

Comparison Between 60 and 25 Cycles

Summed up, 60 cycles at that time was better for incandescent and alternating arc lighting and for small motors for general purposes. But for parallel operation of engine-type generators, for conversion to direct current, for large induction motors and for transmission over considerable distances 25 cycles had the advantage. Rotary converters at 60 cycles had been attempted as early as 1896-97, but with 60-cycle engine-type generators, which often did not parallel any too perfectly, the rotaries not infrequently were unsatisfactory in operation. They were delicate machines and not at all in the class of the usual 25-cycle rotaries. Therefore 25-cycle rotaries filled the bill in the most satisfactory manner, and they represented a big percentage of the load on many of the large plants.

But with the coming of the turbo-generator about 1900 and its rapid growth in the following years there were indications of a change. These generators ran smoothly in parallel and 60-cycle rotaries worked better on them. There were, however, physical limitations in those earlier 60-cycle rotaries which greatly handicapped them. At the maximum peripheral speeds of the armatures and commutators of those days the pole and brush-holder pitches were really too small to allow high-class machines. Peripheral speeds of 4,000 ft. to 4,500 ft. per minute at the commutators and 7,000 ft. to 7,500 ft. per minute at the armature core were considered quite high, and yet these gave 7 in. to 7½ in. between brushes and about 12 in. pole pitch. These were too small to allow good designs in those days. But about 1908-9 the designing engineers took a bold step and deliberately raised the peripheral speeds about 25 per cent. This may sound easy, but it was not so easy for the manufacturers. There were commutator difficulties, of course, as commutator building is an art which has to be relearned, by much bitter experience, every time a radical increase in speed is made. Most of the old troubles due to the former physical limitations of brush and pole pitches disappeared, but the rotaries were still expensive and inefficient, owing principally to the large number of poles.

The adoption of commutating poles on 60-cycle rotaries, some three or four years later, marked another big step foward. With commutating poles the commutating constants could be doubled, thus allowing the number of poles virtually to be halved. The iron, copper and windage losses shrunk to about half for the same capacity of machine, thus increasing the efficiency of the 60-cycle rotary, including its transformers, to approximately that of its 25-cycle rival. This decrease in the number of poles also meant a considerable reduction in cost, so that the 60-cycle rotary became a good competitor of the 25-cycle rotary for general service conditions.

Genesis of Power as a General Commodity

About this time a new development was taking place in the power-plant situation. Heretofore almost all alternating-current plants had been built with some special service in view, such as lighting in the case of central stations, or rotary converters in case of railway plants, or motor service largely in case of industrial plants. There

were practically no general service power stations. About this time the sale of power as a general commodity was beginning, and the coming of the satisfactory 60-cycle rotary gave an impetus to the development of 60-cycle general-service generating plants. As these stations grew they began to reach out and take over the smaller individual, or isolated, industrial and railway plants. The more they absorbed, the bigger they grew, and the bigger they grew, the more they were able to absorb. The growth of such central stations or public utility plants in the past ten years has been amazing. They have grown by leaps and bounds, so that now they handle almost any service regardless of size and kind. Even the steel mills are now using purchased 60-cycle power to a considerable extent.

In the transmission of power 25 cycles appeared to have a decided advantage over 60 cycles only a few years ago. But with the adoption of the synchronous condenser for line regulation purposes 60 cycles has been able to cover wider and wider fields in a satisfactory manner. Curiously, the use of the synchronous condenser for regulating purposes was proposed as early as 1893 and patented, but the patent had virtually expired before the scheme came into general use. It should be understood, however, that the frequency of 25 cycles still possesses advantages over 60 cycles for transmission, but these are not now considered as of controlling importance, except possibly for very long lines.

By 1915 the situation could be summed up as follows: The 60-cycle turbo-generator presented speed advantages in its 3,600-r.p.m. and 1,800-r.p.m. units, against 1,500 r.p.m. for 25 cycles; for lighting purposes 60 cycles was unquestionably better, and also for general-purpose motors, with speeds of 1,800, 1,200 and 900 compared with 750 for 25 cycles; in conversion to direct current, 60 cycles was approaching very close to 25 cycles in operation and was equal to 25 cycles or better in cost; for transmission it was satisfactory for quite long distances. Therefore, for central stations, for furnishing power for all purposes to the general public, 60 cycles was distinctly taking the lead. In fact, the sales of the manufacturing companies had indicated the general trend several years before this. In 1912, at an A. I. E. E meeting at Schenectady, the writer stated that 60 cycles was then taking the lead over 25 cycles, and the General Electric Company engineers corroborated the statement. Again in 1918 * the writer brought out clearly that 60 cycles was the coming general-purpose frequency and that in fact it was already here on a large scale.

Sixty Cycles Becomes Standard

Thus, with the coming of the great central stations in the past ten years, 60 cycles has become the standard for general service. But that does not mean that 25 cycles has become obsolete. There are too many 25-cycle "districts" and too much purely 25-cycle service to allow that. Fewer 25-cycle generating units are sold than formerly, but most of them are of quite large capacity. These cover the growth of existing 25-cycle systems. Many of the larger cities have both 25-cycle and 60-cycle plants, but the rate of growth of the latter has been much greater than of the former during the last few years; and the continuance of two such systems has meant the construction of much larger apparatus for simply tying together the two frequencies.

Evidently a single frequency may come eventually, but it is far off. There is too much tied up in 25-cycle systems to allow their replacement for many years to come. But there is little danger of any new frequency coming into general use or replacing 60 cycles. Attempts have been made at various times to introduce other frequencies, usually on a small scale, but none of them have been able to make serious inroads on the existing fields—80, 66 2/3, 50, 40, 30 and 15 cycles have been brought forward and tried, usually with more or less good reason for their installation, but they did not persist. It is a question, however, whether 50 cycles would not really be better than our 60 cycles for general purposes. It gives a two-to-one ratio to 25 cycles, which would certainly be convenient at times; but no matter what advantages 50 cycles would possess over 60, it is too late now to make the change.

It must not be thought that the introduction of 25 cycles was a mistake. Without it or some other relatively low frequency undoubtedly the electrical art would not have attained its present advanced position. It helped enormously in putting the polyphase alternating-current system in the forefront. It might be called a "pacemaker" for the 60-cycle rotary converter, for the 25-cycle rotary set a standard that the 60-cycle could attain only after fifteen to twenty years of engineering effort; and it must not be forgotten that the 25-cycle rotary converter "killed" the large direct-current railway generator business and thus revolutionized the electric railway business.

American Engineers' Fight for Standards

There is another phase of the frequency problem which should be mentioned. In some parts of the world it is, or was, not unusual to find several frequencies differing by only a few per cent from each other. How could this happen? Yet it is the easiest thing possible, if not prevented by constant watchfulness. For instance, a manufacturer may build a thirty-six-pole alternator for 200 r.p.m., 60 cycles, for a certain customer. Another customer comes along who wants a very similar machine, but for 180 r.p.m. What would be easier than to sell the same machine, but at 10 per cent reduced voltage so that the same transformers can be used? It would have a frequency of 54 cycles instead of 60—but look at the money saved over building a new generator of forty poles. This has been the temptation thousands of times, but the engineers of the American manufacturing companies have been too far-sighted to allow such a practice, knowing what it meant, in confusion and added cost, in the end. To them must be given the credit for saving us from this situation. They have fought pretty consistently for standardization of frequency and voltage, and, especially as far as frequency is concerned, their record is most commendable compared with the rest of the world.

As has been shown, the coming of the turbo-generator and the development of a satisfactory 60-cycle rotary have had much to do with putting 60 cycles in the lead. But the manufacturers and the engineers who have had the most to do with these two developments had also leading parts in the development of the 25-cycle system. Apparently they played no favorites. They were willing to push both systems to the limit and let the better one win on its merits. Rightly, no real attempt was made to force standardization in favor of any individual or company preference. If standardization had been forced through eighteen or twenty years ago, it would have meant 25 cycles; but ten years later it would have been 60 cycles. This is a clear illustration of the dangers which are to be encountered in forcing standardization.

*"The Technical Story of the Frequencies," A. I. E. E., Washington, D. C., January, 1918.

Charles P. Steinmetz*

Louis Duncan*

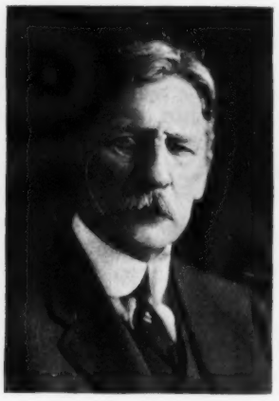
B. G. Lamme*

Outstanding Engineers of the Electrical Industry

Some of the inventors and consultants who typify development in the art

Charles F. Brush

Elihu Thomson



Frank J. Sprague

John J. Carty

William Stanley*

Louis Bell*

Bion J. Arnold

Edward Weston

*Deceased

Electrical Engineering Twenty-five Years Ago

Tungsten filament unknown, but the inclosed arc had arrived — Eleven 3,500-kw. generators ranked as a "mammoth" plant — Transmission at 33,000 volts new and bold

By J. E. Woodbridge

Resident Engineer Ford, Bacon & Davis, San Francisco

AS A SUITABLE contribution to the semi-centennial issue of the ELECTRICAL WORLD, the writer has been asked to comment on the condition of the arts and industries reviewed by that publication at the middle of the fifty-year period. The writer is presumed to qualify as a historian of that period since he was the last editor of the ELECTRICAL WORLD for the original publisher, W. J. Johnston, previous to the sale of the publication to James H. McGraw in 1899, twenty-five years ago.

On attempting to recollect the conditions of that time and to contrast them with those of the present day, the greatest change appears in the central-station business. At that time the load of the central station was primarily lighting. The Moonlight Schedule was then a regular annual supplement of the ELECTRICAL WORLD—as, indeed, it has continued to be—and many central stations in the smaller towns ran on such a schedule while others ran their alternating circuits continuously, their power circuits when wanted and their arc circuits on the schedule.

The incandescent lamp was of the carbon-filament type, the tungsten filament even in its most primitive and highly breakable form being then unknown. The tantalum lamp was an after-development, and if I recollect rightly, the metallicized carbon filament later known as the "Gem" lamp was not then in production. The lamp base was then becoming standardized, but three bases were still in use, the Edison screw base as we have it today, the Thomson-Houston with a central hollow screw and the Sawyer-Mann or Westinghouse of a push-in type. The production of calcium carbide by the electric furnace had been started on a commercial scale, and the acetylene lamp was looked upon as a serious competitor of the electric light. The Nernst lamp* was regarded as the coming development, and a great improvement in lighting efficiency was expected from vacuum tubes with high-frequency interrupters.

The original series direct-current open arc and its successor, the double carbon arc, to give all-night lighting, had been superseded by the inclosed arc after many trials and tribulations on the part of numerous experimenters. The inclosed alternating-current arc had also been developed. The magnetite arc had not yet appeared, nor had cored carbons and the flaming arc. The mercury-arc rectifier was unknown, and the only means of supplying direct-current series arc circuits from alternating systems was by means of motors driving series arc machines. The Brush multi-circuit arc machine of 125 lights or larger was rapidly superseding other makes and smaller sizes.

Connected loads were rated in 16-cp. equivalents, the arc lamp at ten such equivalents and motors at fifteen such equivalents per rated horsepower. Motors were usually direct-current. The electric fan was the only energy-consuming appliance. The induction motor was developed, but was expensive owing to patent costs and litigation, development charges and absence of competition. The contest between alternating-current and direct-current systems was dying out, with the recognition that both were required and could be worked together to advantage, but polyphase systems with direct-current distribution were still in embryo.

The Central Station of 1899

The prevailing type of central station of 1899 contained a number of high-speed engines belted to direct-current series arc machines of various makes and sizes; alternators, some polyphase or monocyclic, 60-cycle, 2,200-volt, others single-phase, 1,100-volt, of higher frequencies, and 230-volt or 550-volt direct-current dynamos for commercial power or street-railway purposes. The output in kilowatt-hours was not metered but probably required about 10 lb. of coal. The Arnold central-station design with dynamo armatures mounted on quills driven by magnetic clutches was considered promising. The possibility and advisability of large prime movers directly coupled to generators for all purposes was recognized, but developments in that line were then largely on paper. The steam turbine was still in the experimental laboratories of the makers.

Greater New York, which was then newly formed to include Brooklyn, Staten Island and the Bronx,† had a total central-station load, excluding street-railway stations, of about 1,250,000 16-cp. equivalents, and it is of interest

* In spite of the publicity given this lamp twenty to twenty-five years ago, it has been almost forgotten and a brief description may be of interest. It consisted essentially of a refractory oxide, such as magnesia, which becomes a conductor at incandescent temperatures. It required, of course, a heater to start it and a ballast resistance, as it had a negative temperature characteristic of resistance. Its development at an expense to the Westinghouse company probably amounting to several hundred thousand dollars is an example of the speculative character of industrial research.

† At the celebration of the formation of the Greater City, January 1, 1898, City Hall Square, which normally was illuminated by nine arc lights, was festooned with twenty-seven extra arcs.

to note that isolated plants in the same city had a connected load of about 800,000 equivalents. In Chicago the connected load of the isolated plants was listed as greater than that of the central stations. On account of the fact that their system was the best adapted to the profitable business in the congested districts of the large cities, the Edison licensee companies usually operated the most highly developed central stations. The system of the New York Edison Company (with which I was most familiar) may be briefly described as follows:

The company operated five steam plants with several large storage batteries. Its show station was the old original Duane Street plant, containing engines and generators on the ground floor, boilers above and coal pockets on top. The largest unit was a 2,500-hp. quadruple-expansion engine directly connected to two 800-kw. smooth-core Gramme-wound armatures with annular commutators, made up of part of the windings. Coal consumption was 4 lb. to 5 lb. per kilowatt-hour, but coal was cheap. The Brooklyn Edison Company was then building a water-front station to contain three-phase, 25-cycle units with a capacity of 1,500 kw. each. The rates of the New York Edison Company are of interest, together with the fact that that company was then unique in publishing its entire schedule. They were based on 1 cent per 16-cp. lamp-hour, including lamp renewals, with discounts up to 40 per cent for consumers using $1,000 worth or more per month. The arc-light base was 10 cents per 8-amp. lamp-hour and the power-service base was 10 cents per kilowatt-hour with discounts up to 60 per cent, making the lowest possible rate 4 cents.

The plant of the Niagara Falls Power Company had just been extended by the addition of five 5,000-hp. units similar to the original three, with double hydraulic runners having an outward radial flow and with umbrella-type external revolving-field generators. In spite of the fact that the Niagara plant was of unprecedented size, 40,000 hp., all switches were of the air-break type. Switching under oil had been adopted in an oil-refining plant primarily to suppress all arcing and had been tried at about 5,000 volts on some of the Edison high-tension developments, but was far from being standardized for alternating-current work. The largest transformers in the world were those of the Niagara plant, rated at 935 kw. each. The high-tension circuits, 11,000 volts, by which power was transmitted to Buffalo were protected by air breakers similar to those on railway switchboards with long fuses in shunt with the breakers. It is not necessary to comment on the performance of such equipment when short circuits occurred. Synchronizing was done with lamps.

West Led in Transmission

High-voltage transmission had, of course, reached its highest development in the West. The experiments of the Westinghouse company at Telluride were then under way. The Snoqualmie plant near Seattle was being built with four 1,500-kw. revolving-armature machines and a line designed for 25,000 volts. The Southern California Power Company proposed an 80-mile transmission at 33,000 volts. The Lachine Rapids plant, near Montreal, was being built with six vertical-shaft turbines driving one generator shaft through step-up bevel gears. The Shawinigan plant was proposed. The production of aluminum in the electric furnace by the Hall process had started, but the cost was still too high for it to compete as an electrical conductor.

The electric cab was then the only successful type of horseless carriage. The most ambitious development in this line was a group of about seventy-two electric cabs modeled after the English hansom, but of course with four wheels, operated in New York City by the Electric Vehicle Company.

The design of dynamo-electric machinery was then much as it is now except that the commutating pole had not been adopted for direct-current machines, although one generator, the Thomson-Ryan, was made with distributed compensating series-field windings. The revolving-field alternator was superseding the revolving armature. Inductor-type alternators were still being manufactured. Silicon steel was yet to come. How the coils were ever held in place on the old smooth-core armatures of alternators, arc machines and bipolars, seems a mystery now. Frequent rewinding was a regular procedure and was driving the smooth core into the discard.

The Spanish-American War had been fought the year before and had benefited electrical manufacturers chiefly by orders from the government for searchlamps and submarine cable for bombs. The conclusion of the war was celebrated by a peace jubilee in Philadelphia, a feature of which was an industrial show, largely electrical. The war was followed by an industrial expansion described by the ELECTRICAL WORLD as enormous, but insignificant in comparison with the ups and downs of the decade starting with the World War.

Traction, Telephony and Telegraphy

The street-railway systems of the large cities had been largely changed from horse to electric traction with the exception of those in the borough of Manhattan, in which the Metropolitan Street Railway Company was then installing the open-circuit system in place of horse and cable lines, including the Broadway cable. For the supply of this system the company was building at the foot of East Ninety-sixth Street a "mammoth" plant to contain eleven 3,500-kw., three-phase, 25-cycle, 6,000-volt generators, driven by vertical cross-compound Corliss engines at 75 r.p.m. This plant has, I believe, since been abandoned, but the 990-kw., 550-volt converters supplied from it may still be in use.

The first Boston subway was constructed and experiments were being made on it with the Sprague multiple-unit system which had been adopted on the "Alley L" in Chicago. The first New York subway was still in the proposal stage. The Manhattan Elevated was steam-operated, although its management had announced that it would be electrified. There was only one Brooklyn Bridge, on which cars were operated by cable with electric motors for switching at the terminals. The wild growth of interurban electric railroads throughout the Middle Western States had not yet begun. Steam-railroad electrification was limited to the Baltimore tunnel, the Hoboken Shore Road, two locomotives running between Lockport and Tonawanda, and some experimental lines operated by the New York, New Haven & Hartford in New England. The Park Avenue tunnel wreck, which was the occasion for legislative enactment compelling electrification of the Grand Central Terminal, had not yet occurred. The electrification of steam railroads was as generally discussed in the columns of the ELECTRICAL WORLD and elsewhere as it is today. The alternating-current railway motor of the series type was unknown, although the induction motor had been tried abroad. Direct-current voltages above 600 were not in use for railway work.

Telephony was beginning to embark on long-distance interconnections. The metallic circuit had superseded the

ground return, and central-energy plants were rapidly replacing the consumers' primary batteries and hand-operated magnetos. On the occasion of the writer's visit to the Trans-Mississippi Exposition in Omaha in 1898, the privilege was accorded him of talking from Omaha to his office in New York City. The attempt was a total failure, the operators in Pittsburgh and Chicago having to repeat the conversation. The loading of long-distance telephone lines was only proposed. There was no operative repeater.

Telegraphy was limited to hand-operated Morse duplex or quadruplex. Marconi's experiments in wireless had begun and a company had been formed in England to exploit this development commercially. The ELECTRICAL WORLD said editorially—and the article was presumably written by the writer—that the use of wireless would probably be limited to communication between points otherwise difficult to reach, such as lighthouses from the mainland. The coherer was the detector then in use, the electrolytic detector not having been developed. There was no cable across the Pacific.

The electrical manufacturing companies lined up about as follows: The General Electric Company, with factories at Schenectady and Lynn and its lamp works at Harrison, N. J., had not begun to absorb competitors by the acquisition of the Stanley Electric Manufacturing Company, the Sprague Electric Company, the Fort Wayne Electric Corporation, the Siemens & Halske Electric Company of America, the Excelsior Company and many others. The Walker Company of Cleveland was absorbed by the Westinghouse Electric & Manufacturing Company in 1898. The Bullock Electric Manufacturing Company had not yet been absorbed by the Allis-Chalmers Company.

Among the contributors to the ELECTRICAL WORLD of that day, many of whom are still active, while others are no longer with us, were Frederick Bedell, Louis Bell, H. S. Carhart, J. S. Codman, J. R. Cravath, A C. Crehore and G. O. Squier, F. B. Crocker, S. E. Doane, A. E. Dolbear, A. R. Everest, L. A. Ferguson, R. A. Fessenden, W. E. Goldsborough, R. S. Hale, C. D. Haskins, George T. Hanchett, J. F. Hobart, E. J. Houston, A. E. Kennelly, B. G. Lamme, R. D. Mershon, C. O. Mailloux, K. B. Miller, E. E. Northrup, F. A. C. Perrine, W. B. Potter, Joseph Sachs, C. F. Scott, Samuel Sheldon, C. E. Skinner, C. P. Steinmetz, P. H. Thomas, Elihu Thomson, F. W. Wilcox and A. J. Wurts.

Steam Power and Water Power

How the economic conception of their relation to each other has changed—Water power plants, except in the Far West, must play the minor part of auxiliaries to steam production

By Harold W. Buck

Consulting Engineer
Vielé, Blackwell & Buck, New York

THE engineering progress which has taken place in recent years in hydro-electric development has not been specially radical. Methods of construction of high-head and low-head plants are about as they were ten years ago. There has been a considerable expansion in the sizes of hydro-electric units, culminating in the colossal units of 70,000 kw. at Niagara Falls, but here there is a question as to whether mere size has not been overdone. The extremely large units actually cost more per kilowatt than units of smaller capacity, and difficulties in power-house substructure construction are experienced with very large units due to the great size of waterways required. Furthermore, with the widely varying flow in our rivers a considerable subdivision of units in the plant is desirable in order to conform efficiently to the varying hydraulic input.

The most important change in hydro-electric design which has taken place has been in the adoption of higher specific speeds for turbine runners and consequently a higher rotative speed for the electric generators driven by the waterwheels. This has resulted in a reduction in size and cost of generating machinery and in space occupied, thereby reducing the cost of power-house structures. These high specific speeds have led to the development of

Hydro-Electric Station of the Appalachian Power Company on the New River

special forms of draft-tube design in order to avoid swirls and eddy losses in the discharge of water from the turbine runners. Such draft tubes have introduced construction complications without materially increasing efficiencies, and while they may be necessary under present methods in turbine design, they can hardly be considered a step forward from the standpoint of simplicity and economy of construction.

Turbine efficiencies today of about 92 per cent at full load are not materially above what was actually attained in certain plants ten years ago. In fact, there is little margin for any further improvement in this respect within practicable construction limits.

All this is in sharp contrast with the evolution which has taken place in the thermodynamic engineering of

steam power plants. Here the past ten years have shown a doubling of efficiency, and many radical operating improvements have been consummated. The end has not yet been reached and still further important improvements are already in sight.

The real evolution which has taken place in connection with water power consists in the growing recognition of its proper economic position in the general power system. Only in exceptional cases where large storage is available are water powers any longer regarded as independent sources of power, under which conception many heartbreaking experiences have been met in engineering and financial history. The independent water power has always experienced low water beyond expectation, and output has necessarily been curtailed. Customers have been dissatisfied and earnings have fallen to the danger line of bankruptcy.

This has all been changed under the new economics of water-power development. A water power is now properly regarded as an adjunct to a steam plant and merely as a generator of kilowatt-hours. It should be so rated in installed capacity as to produce annually in combination with a steam power system the greatest number of kilowatt-hours at the lowest possible unit cost. The output at any particular time is of little importance. Even if the hydraulic output should go to zero at times, the system load can be carried by steam, and the water-power development is well justified if the annual product in kilowatt-hours is satisfactory.

Water Power and Peak Loads

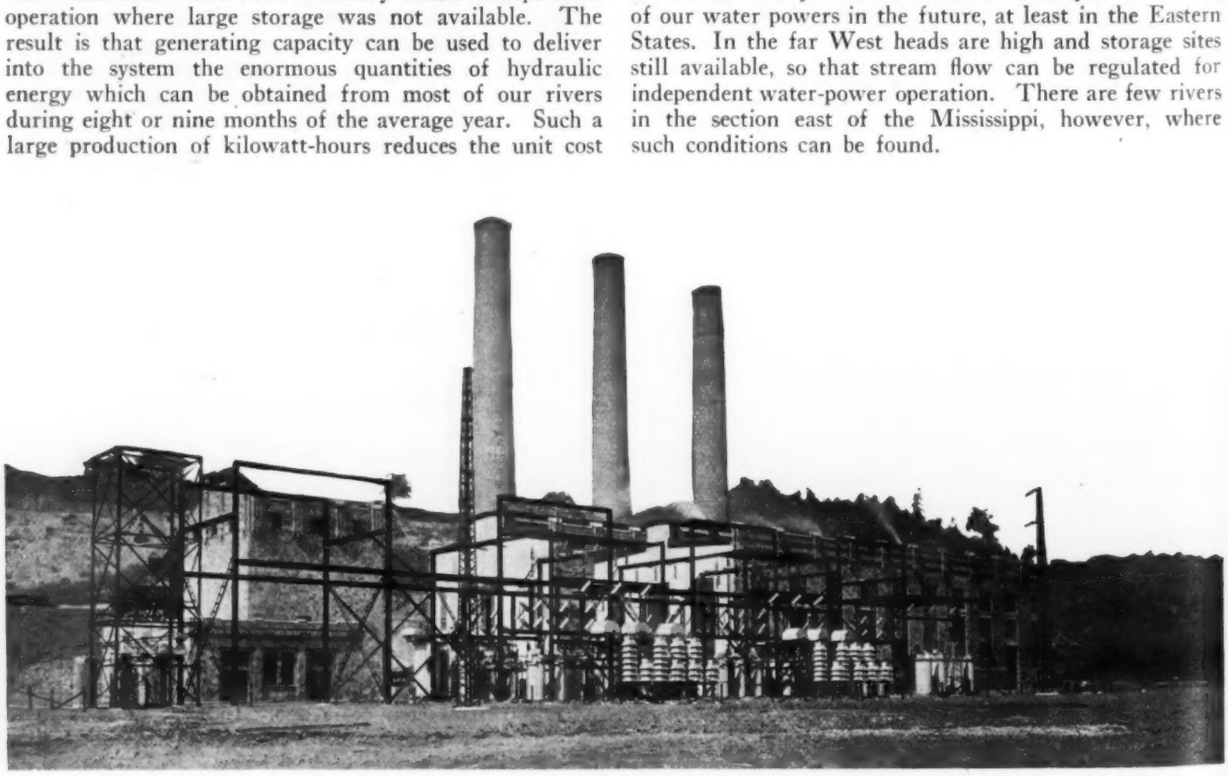
This system of combining steam and water power permits a high installed capacity in water-power machinery regardless of fluctuations in river flow. It is no longer necessary to limit the water-power plant to the minimum-flow condition which was necessary under independent operation where large storage was not available. The result is that generating capacity can be used to deliver into the system the enormous quantities of hydraulic energy which can be obtained from most of our rivers during eight or nine months of the average year. Such a large production of kilowatt-hours reduces the unit cost to a point where a considerable saving can be shown over the operating cost of the equivalent energy produced in the steam plant.

Steam the Primary Power Source

Another most important economic function of the water power on the general power system is in carrying the peak loads and thereby increasing the load factor of the power generated by the steam sources. Almost every water-power development has sufficient storage back of the dam to regulate for any daily load factor. The efficiency of operation of a water power is practically independent of daily load factor, provided there is a sufficient subdivision of units to meet the varying load. A steam plant, however, is highly dependent for economy on uniformity of load. By thus combining steam and water power the load factor of the steam plants on certain power systems has been raised to 80 per cent. The advantages of such a combination are obvious.

We have, therefore, today, instead of the old-fashioned arrangement of an independent water power with steam reserve as a minor consideration, large power systems with steam as the principal power source and water power plants feeding into the system as auxiliaries. This change is economically fundamental and is making possible the successful development of many water powers which would have been failures under the old scheme. The extension of the superpower idea works in favor of this treatment of water powers and affords a vast reservoir into which hydraulic kilowatt-hours can be fed from many large and small hydro-electric developments at widely scattered localities.

This combination of steam and water power is sure to show advantages which neither source could show alone. It is this combination which will probably constitute the chief justification for the development of most of our water powers in the future, at least in the Eastern States. In the far West heads are high and storage sites still available, so that stream flow can be regulated for independent water-power operation. There are few rivers in the section east of the Mississippi, however, where such conditions can be found.



Glen Lyn Steam Station of the Appalachian Power Company

Forty Years of Central-Station Development

Foresight of the master minds of the '80s is vindicated by the standard generating equipment in the great power houses of America today—Recommended practices

By William C. L. Eglin

Vice-President and Chief Engineer
Philadelphia Electric Company

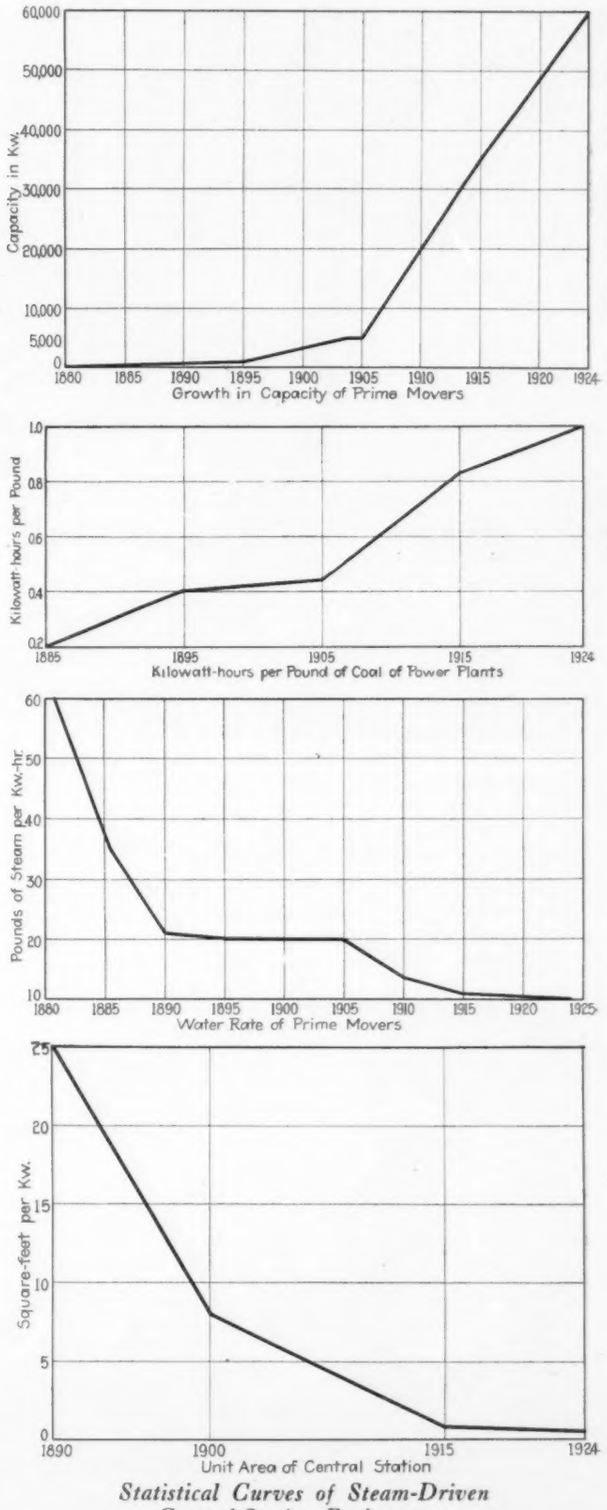
THE first exhibition of electric lighting (the arc light) was at the Royal Institute of London by Sir Humphry Davy in the year 1810, but it was not until the late '70s that this discovery came into extended commercial use. The work of Brush and others in this country in the development of the double-carbon lamp and suitable constant-current, variable-potential generators made possible the commercial operation of this form of lighting on series circuits.

The succeeding years were productive of great developments in electric dynamos and motors. Special designs were developed to meet the various requirements of industrial and domestic use. This period saw numerous types of generators installed in individual power plants for the particular classes of service for which they were suited. The master minds of the '80s fully realized the necessity of a generator and system of distribution which would be capable of giving universal service for light, heat and power. Edison, Thomson, Westinghouse, Stanley, Weston and others were advocates of systems applicable for universal service.

Importance of Diversity Not Grasped

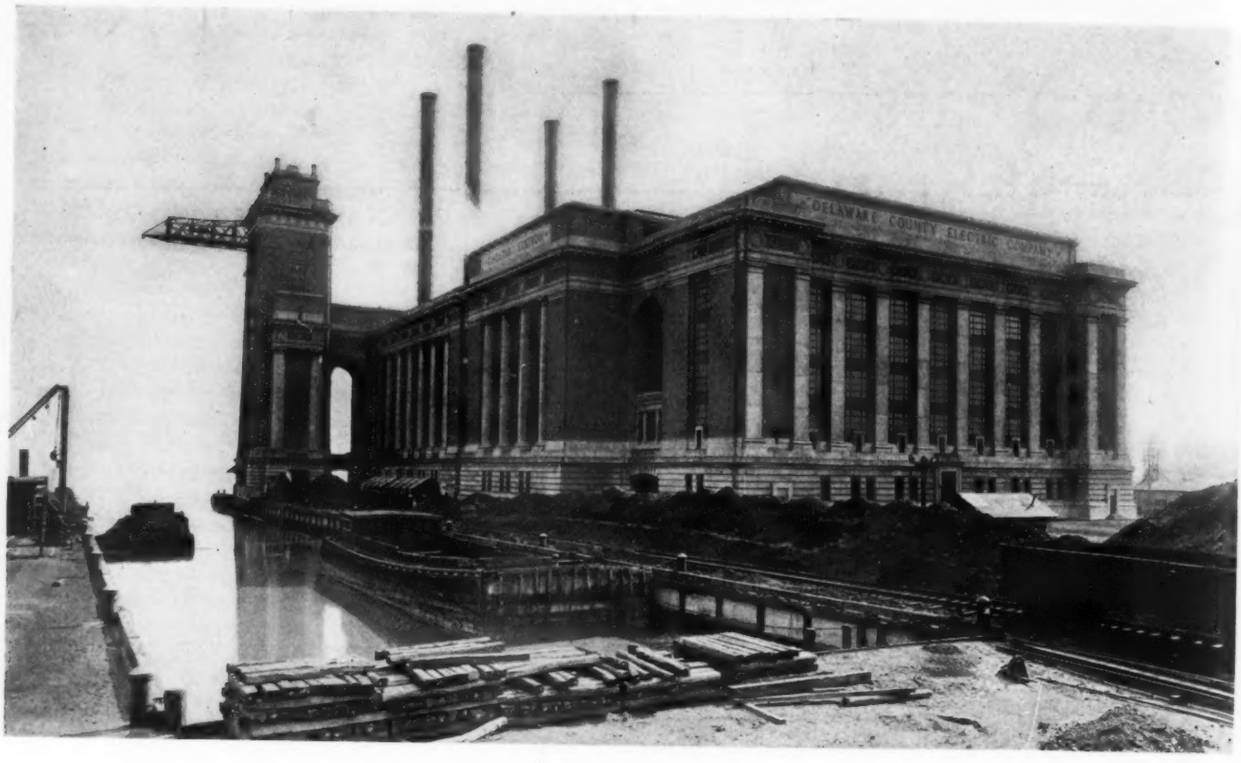
During this period a great number of companies were organized and installed plants using the series system for furnishing street lighting and lighting in large units in industrial and commercial buildings in which large areas had to be illuminated. It was but natural that these companies should take advantage of the new inventions of the time and install low-voltage direct-current apparatus for direct distribution in the vicinity of their power houses, higher voltage (such as 500 volts) direct-current generators to meet the demand for electric power which at that time could best be served by direct-current electric motors, and later alternating-current generators with transformers to serve territory more remote from the power houses.

The executives of these companies concentrated their efforts on grouping the loads of similar character on generators suitable for the particular purpose, and apparently they did not grasp the importance of diversity which had been so clearly stated by the master minds previously mentioned. This resulted in a number of different types of generating apparatus being installed in one station, not



Statistical Curves of Steam-Driven Central-Station Performance

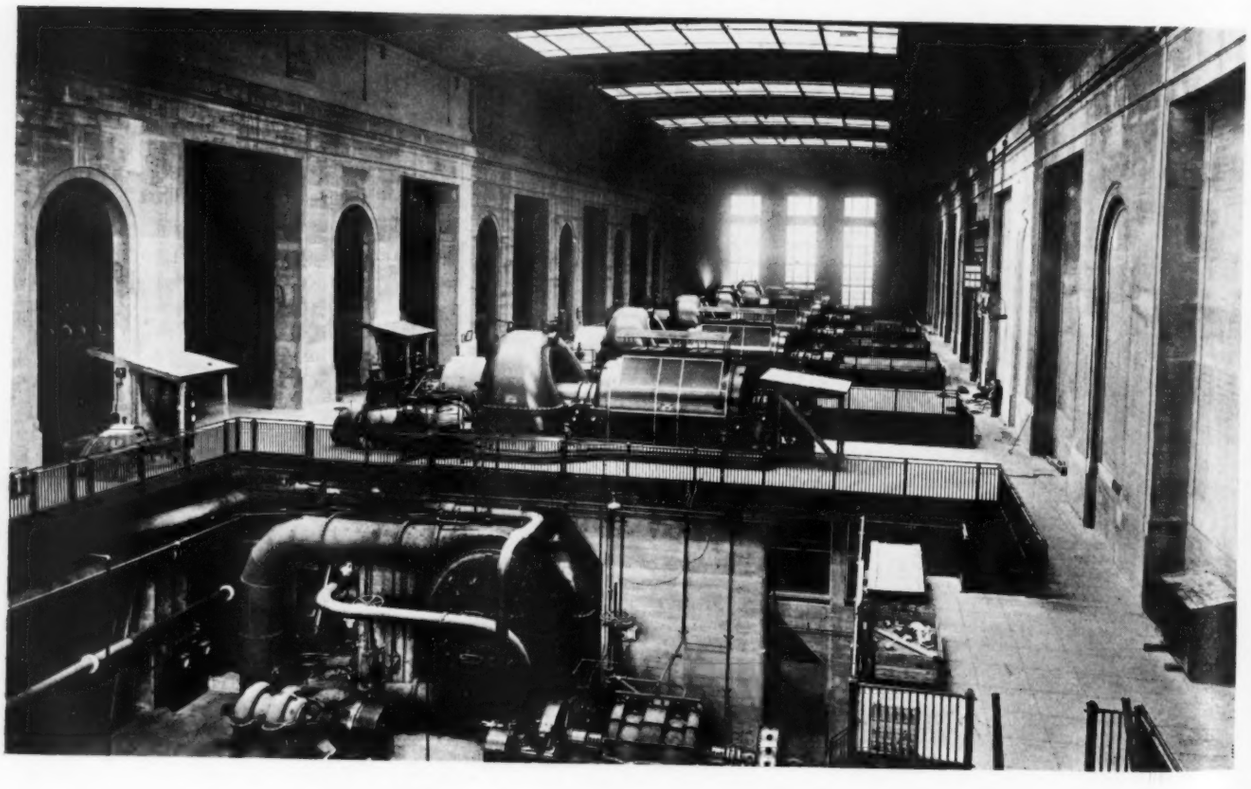
any of which were interchangeable and which required numerous spare parts, as the size of generators was relatively small. There were also complications in line shafting owing to the belt drives and to the very large number of circuits leading out from the plant. Many of these older plants had large towers from which the various circuits were distributed on pole lines and which were the frequent cause of the destruction of the plant from fire.



Chester Station

Two Plants of the Philadelphia Electric Company Which Typify the Progress of the Industry

Interior of Delaware Station



With the growth of the business and the necessity for reliability of service, the complications of such plants forced attention to the engineering problems involved, and a gradual development has taken place, resulting in the elimination of all of the superfluous varieties of generating apparatus. Thus a uniform system—polyphase, alternating current, 60 cycles—has become the standard generating equipment in the United States today.

This great step has allowed engineers interested in power development to concentrate their attention upon two essentials—namely, the maximum economy which can be obtained from the fuel and the maximum reliability of operation of the apparatus. Advances made in these directions are graphically shown in the accompanying charts.

It was natural that in the earlier developments most of the plants should be operated non-condensing, and the most marked advance was the erection of generating stations where condensing water was available and the operation of all of the steam units condensing. There was naturally also much investigation into all of the power-using equipment of the station itself, and to all of the station auxiliaries individual study has been given.

The most helpful investigation in the design of a station was found to be the preparation of a heat balance showing the utilization of the heat of the fuel and its distribution throughout the plant. This clearly proved that the greatest single loss was in the condenser, and as the steam engine had been superseded by the steam turbine it was possible to reduce these losses by bleeding the turbine at some of the lower stages, since a part of the heat which would otherwise be thrown away in the cooling water could be used to heat the feed water. By bleeding from several stages the feed water could be heated to the temperature of the water in the boiler, thus saving heat at both ends of the cycle.

The use of bleeder steam for feed-water heating eliminated the necessity for using an economizer, and the heat of the flue gas formerly used in the economizer was now available for preheating the air used for combustion. This is done so successfully that the gas temperature in the chimney is considerably lower than before.

Advantage of Superheat

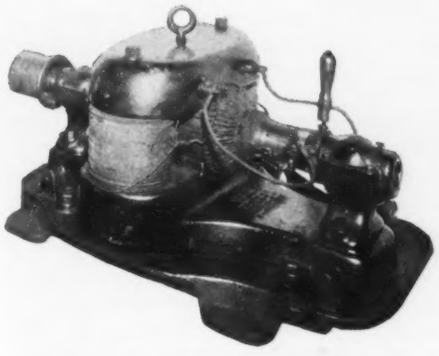
It was early recognized that the use of a high degree of superheat was very desirable, but the difficulty of obtaining materials which would retain their strength and shape under the influence of the continued application of high temperature limited the superheat to relatively low values. This has to some extent been overcome so that higher temperatures are coming into use. Much the same effect is, moreover, obtained by reheating the steam before it passes through the lower stages of the turbine, where the superheat is of the most advantage. This plan involves considerable complication in piping, however, and is not used extensively at present.

Original "Daft" 3-Hp., 220-Volt Direct-Current Shunt-Wound Motor

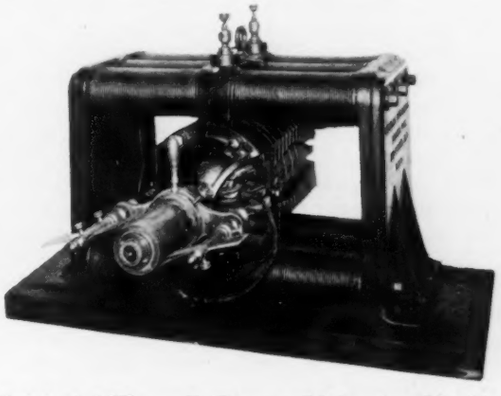
The use of higher steam pressures is being studied, and considerable progress has been made in high-pressure developments. The high pressure results in higher efficiency, but this is not entirely a clear gain. With the increased pressure a stronger construction is necessary, which is partially offset by the reduced steam volume. The net results expressed in cost per unit of output, including the charge on the additional investment and higher maintenance cost, may not be lower and may even be higher, in spite of the increased economy.

For auxiliary drives the greatest economy can be obtained where the power required is taken from the main turbine, which may be done in any one of three ways—either by a separate generator mounted on the main turbine shaft, or by transformers directly connected to each generator and supplying the auxiliaries associated with the particular unit, or by transformers connected to the main bus. By so doing economy is obtained, and by having a small reserve in independently driven units reliability is obtained.

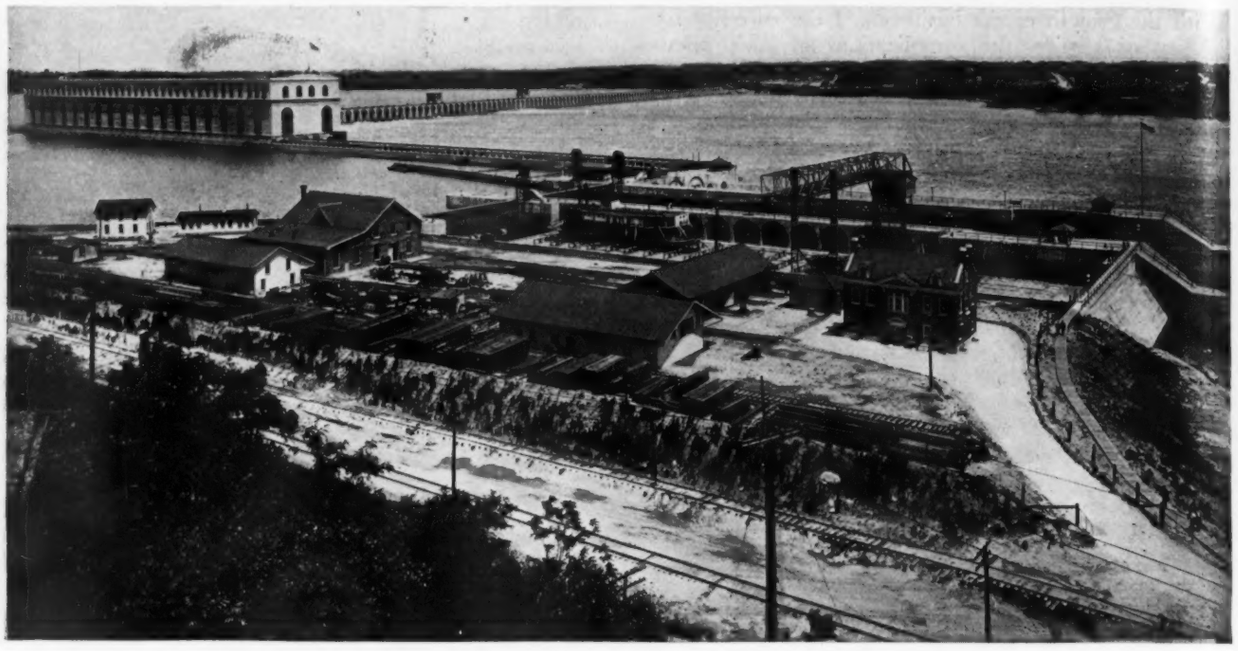
Summing up the trend of modern design, increased economy may be obtained by heating feed water by bleeder steam, heating the air for combustion by the flue gases, use of higher steam pressures, use of higher steam temperatures, reheating of the steam before passage through the lower stages of the turbine, use of pure feed water obtained by evaporators and de-aërators, and giving proper attention to the heat balance of the plant.



Early "Diehl" 7½-Hp., 220-Volt Shunt-Wound Motor



Original "Weston" Twenty-Light Arc Machine Built in Newark in 1878



Water-Power Development of Mississippi Power Company at Keokuk, Iowa

Forty-two Years of Hydro-Electric Engineering

Rating of nation's water-power plants has risen from 250 cp. to 8,000,000 hp.—Ten themes that would serve for chapter headings in a brief history—Praise and blame

By Hugh L. Cooper

President Hugh L. Cooper & Company, Inc.

THE first electric lighting plant with water power as the prime mover was built at Appleton, Wis., in 1882, with a capacity of 250 cp. The first alternating-current transmission line in the United States was built in 1889 by the Willamette Falls Electric Company at Oregon City, Ore. Here the prime movers were two 300-hp. Victor turbines belted to 4,000-volt, single-phase generators, and the power was transmitted to Portland, Ore., a distance of 13 miles.

In 1893 the first polyphase plant was installed by the Redland Electric Light & Power Company of Redland, Cal., and here the prime movers were two Pelton waterwheels operating under a 295-ft. head, driving two 250-kw., 2,400-volt, three-phase generators running at 600 r.p.m. This power was transmitted a distance of 7½ miles to Redland, where it was used for lighting and industrial motors. In 1924 there is installed in the United States alone more than 8,000,000 hydro-electric horsepower for general use, with considerably more than 2,000,000 additional horsepower under construction.

Tables I and II show the approximate rate of increase in the use of power from 1895 to date that has obtained in California and the United States as a whole. An intelligent record of engineering, financial and construction experience for the time between the Redland installation in 1893 and the present would fill many books several times more voluminous than the Encyclopædia Britannica. The present-day enjoyment of hydro-electric power is fundamentally due to the willingness of private capital in the past to venture into the pioneer's field, hoping thereby to improve efficiencies, extend business, earn more dividends and, in these later years, have these dividends based upon the best public interest.

To compose a two-thousand word review of outstanding events of special interest in the history of the development of hydro-electric power to date is difficult because so many unique and appealing chapters are found all through the records. As the result of a hasty backward look at this picture, the following items have been selected as being prominent in the story, but they are not necessarily set down in logical relationship to one another.

1. After 1900, when the hydro-electric industry began

to expand rapidly, the investing public absorbed easily the hydro-electric securities that were offered, only to be sadly punished later because of much dishonest promotion and ignorant and unprofessional work on the part of engineers, with the result that by 1907 property representing an investment of more than $120,000,000 in hydro-electric securities was in the hands of court receivers.

One of the principal causes of this catastrophe was the failure of bankers to use ordinary discretion in the selection of their engineers, and with this the willingness of engineers with previous good records to take the responsibility of doing something they did not know anything about. During this period there were aggravated cases known where certain engineers told their intimates: "Of course, we knew the financial estimates were far too low,

TABLE NO. I—APPROXIMATE TOTAL COMMERCIAL HYDRO-ELECTRIC POWER IN CALIFORNIA

	Population		Hydro-electric Power Developed		Horse-power per Capita
Year	Number	Per Cent Increase	Horsepower	Per Cent Increase	
1880	865,000	....	.....	....	.....
1885	1,072,000	23.9	.....	....	.....
1890	1,213,000	13.2	500	....	0.0004
1895	1,345,000	10.8	7,681	1,440	0.006
1900	1,486,000	10.5	38,500	400	0.025
1905	1,884,000	26.8	134,216	248	0.075
1910	2,378,000	26.2	395,000	197	0.17
1915	2,876,000	21.0	610,000	54	0.20
1920	3,427,000	19.2	1,150,000	88	0.35
1924	3,970,000	15.7	1,500,000	31	0.40

TABLE II—APPROXIMATE TOTAL DEVELOPED WATER POWER IN THE UNITED STATES, INCLUDING PLANTS OF 100 HP. OR MORE

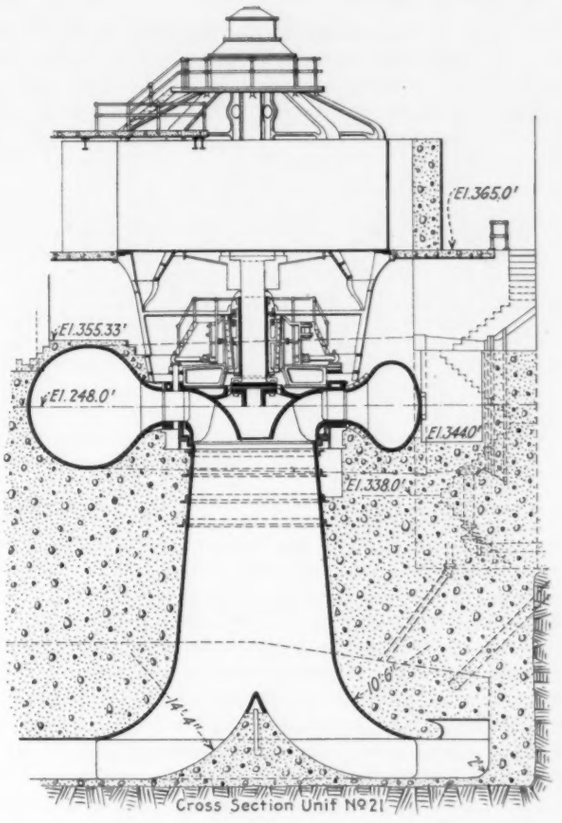
	Population		Water Power Developed		Horse power Per Capita
Year	Number	Per Cent Increase	Horsepower	Per Cent Increase	
1890	62,947,714	10.0	.....	....	.....
1895	69,352,318	10.2	1,700,000	38.9	0.025
1900	75,994,575	9.6	2,275,000	33.8	0.030
1905	83,748,421	10.2	3,050,000	34.0	0.035
1910	91,972,266	9.8	4,225,000	38.6	0.050
1915	99,667,812	8.4	5,750,000	36.1	0.060
1920	105,710,620	6.1	7,550,000	31.2	0.075
1924	115,374,961	9.7	9,200,000	20.3	0.080

but the bankers would have stayed out had they known the real cost; now that they are in they must complete."

Fortunately for the fair name of the engineering profession, such malpractice and similar misrepresentations with respect to the quantities of power producible and costs of maintenance, and other ignorant representations with respect to water power, are largely eliminated now, and only a few more years will be required to bury what is left of this handicap. The investing and banking public can now obtain dependable hydro-electric advice in a wide field of successful experience in the United States without any fear of a repetition of the earlier difficulties to which reference has just been made.

Attitude of Steam Men

No consideration of the loss and regaining of the public confidence would be complete without referring to our estimable brethren, the steam engineers. For many years our steam engineers and the electric engineers working with them have been very active in trying to belittle the importance of water power. The prejudice of the chief engineers of steam stations against hydraulic developments and the eradication of the prejudice were well illustrated some years ago when a large public utility purchased a considerable block of hydro-electric power, to be transmitted about 160 miles for use in its central steam-power station in one of our largest cities. The chief engineer of the steam station in question was honestly opposed to the whole idea and acted accordingly. The hydro-electric plant was ready for duty about thirty days ahead of the agreed time and was waiting for the date, when, as the result of a telephone emergency call to the water-power station, 35,000 kw. was thrown immediately and successfully on to an untried-out transmission line, all because the central steam station had broken down and would not be able to function for six or eight hours. Since that time this chief engineer has been a strong believer in hydro-electric power. Many other instances of this kind have had similar corrective influences.



Latest 70,000-Hp. Water Turbine Units at Niagara Falls, N. Y.

It would seem as if the demonstrated superior value of hydro-electric power should by this time have taught our steam friends the wisdom of telling the truth about water power. We find, however, as late as May 5, 1924, the utility bulletion issued by the New York State Committee on Public Utility Information claiming "the efficiency and economy of modern steam-power electric plants has been developed to the point where their cost of production of electrical energy is already as low as that of hydro-electric energy."

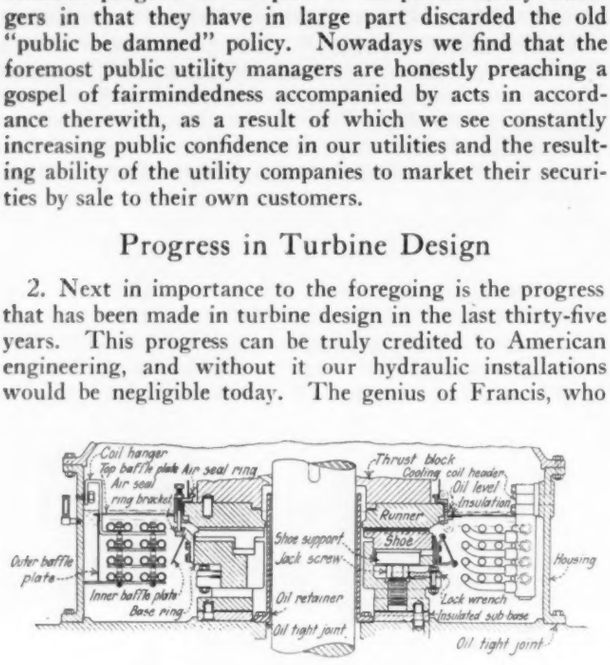
It is unfortunate that misleading statements of this kind are put out, because the inevitable discovery that the statements are not even partially true destroys confidence in the public utility men issuing officially such preposterous claims. We must have the confidence of the public in all our affairs in life if we would continuously prosper, and we cannot expect this confidence if we are careless in our use of the truth.

We may very properly include here also a reference to

valuable progress on the part of our public utility managers in that they have in large part discarded the old "public be damned" policy. Nowadays we find that the foremost public utility managers are honestly preaching a gospel of fairmindedness accompanied by acts in accordance therewith, as a result of which we see constantly increasing public confidence in our utilities and the resulting ability of the utility companies to market their securities by sale to their own customers.

Progress in Turbine Design

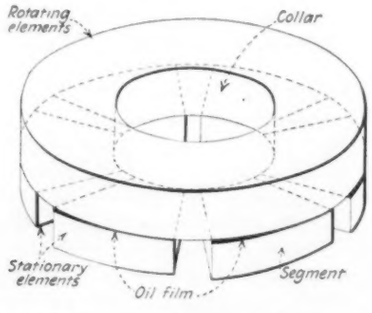
2. Next in importance to the foregoing is the progress that has been made in turbine design in the last thirty-five years. This progress can be truly credited to American engineering, and without it our hydraulic installations would be negligible today. The genius of Francis, who



Kingsbury Bearing on Water Turbines at Muscle Shoals

first developed the Francis turbine, about 1845, has been improved upon by hard and brilliant work on the part of American turbine designers since about 1905. The credit for these great strides in turbine design belongs to the engineers in the employ of the great manufacturers of turbines, and not to the designers of hydro-electric plants.

From the days, twenty-five years ago, when a 1,000-hp. unit was obtained by the use of six runners on one horizontal shaft, or by the use of four or six vertical units bevel-geared to a horizontal-shaft generator, with scarcely any knowledge of efficiency or power capacity, except "bone knowledge," to our present-day single units up to 70,000 hp. from one turbine runner, developing commercial efficiencies of around 92 per cent at speeds even ten years ago believed impossible, is indeed a great if an



Principal Parts of Kingsbury Thrust Bearing

unheralded achievement—one that is over the heads of the public, who are, after all, the real beneficaries from it.

Any statement about the above advance in turbine design would be unjust and incomplete if due credit were not at the same time given to the designers of our present-day successful thrust bearings for vertical shafts, without which the vertical-shaft units would not be available.

In concluding this part of the review it might not be amiss to state parenthetically that Francis, whatever his imaginative powers might have been, could not have possibly foreseen the value of his work; neither could he have suspected that some day a great European builder of turbines would spell his name "Francès" and claim that Francis was a Swiss.

Generation and Transmission

3. Coincident with the marvelous progress in turbine design during the last twenty-five years, and challenging admiration to an almost equal degree, is the progress made in generator and transmission equipment. Of course, independent of hydro-electric power, the use of steam would have produced the results in transmission and generation. Here again American engineering can honestly take credit for an advance in the art of generation and transmission that is distinctly its own.

The vast amount of money necessary for electrical research and general development work has forced most of our best minds into the employ of the great electric companies, and it is hoped that some day these men who live behind great masonry inclosures and devote their lives to a work of vast benefit to the general public will have their value better recognized by the corporations that employ them, receiving as earnings sums more nearly commensurate with the services they render, and that these engineers will, in addition to such financial returns, receive broad public credit for what they have done.

Reinforced Concrete Construction

4. Another chapter that stands out in the history under observation relates to the frenzy that has run (and in part still exists) all over the United States for a long time for the indiscriminate use of reinforced concrete in dams and their power houses. While this frenzy was at the peak one did not quite see permanent work built where sections were thin enough to develop transparency. The use of thin sections loaded down with patented rods has been very unfortunate, and past failures due to this plan, plus the many failures the future has in store, will in time collectively eliminate the word "pour" and its attending nonsense from specifications for both reinforced and mass concrete.

Anemia of Engineering Societies

5. Another development in the history under review relates to the present anemic condition of our engineering societies. Some day this anemia will be removed, and until such time our societies will be unable to accomplish successfully the purposes for which they were originally organized.

We as engineers constantly complain of the smallness of our earning power and deplore the ignorance of the general public concerning our work and the physical and financial value of what we do for them. We are ourselves to blame in a large degree for what we complain of, and one of several steps that should be taken in correction would be the attainment of much higher standards of excellence in the papers that are presented at our society meetings. Some of the papers presented are, of course, of great value, but the vast majority of them are not.

When the membership of a society like the American Society of Civil Engineers, with more than ten thousand members, records about four hundred in attendance at annual meetings, there is something wrong of real importance to the profession, and this fact has a bearing upon hydro-electric engineering, because with better work on

the part of our societies in the past hydro-electric engineering would have produced better results for every one concerned.

Technical Publications

6. Another outstanding fact everywhere apparent in the history of the past is the advancement from no publications of a technical character to the great publications of this class now available to all students, at the head of which in America stands the ELECTRICAL WORLD.

There is no greater aid in the designing of anything, whether it is a cartwheel or a great hydro-electric plant, than dependable knowledge as to what has been done before and as to its practical workings. Part knowledge is valueless and most dangerous. Few engineers do well enough financially in their profession to enable them to travel extensively and thus discover what other members of their profession are accomplishing. In the main, therefore, dependence has to be placed for information as to the general advance in hydro-electric engineering upon our technical papers, and too much credit cannot be given the ELECTRICAL WORLD for the assistance it has provided.

Prosperity in California

7. Another outstanding observation that may be here set regarding hydro-electric power is its undoubted influence upon the prosperity of the people who are privileged to use it. It is interesting to observe that in the period from 1895 to 1924 the population of the United States increased about 66 per cent, and in this same period the population of California—served almost entirely by hydro-electric power—increased about 190 per cent. Indeed, the hydro-electric power in use in California in 1924 was about four-tenths of a horsepower per capita—five times the per capita use of hydro-electric power in the United States.

It is acknowledged in all intelligent circles that the rapid and well-regulated development of Californian water power by private capital has played a major part in the extraordinary development of this state as a whole, and this result is an inspiring monument. Engineers in the California district have become able masters of their chosen work, and they have the admiration of all of us.

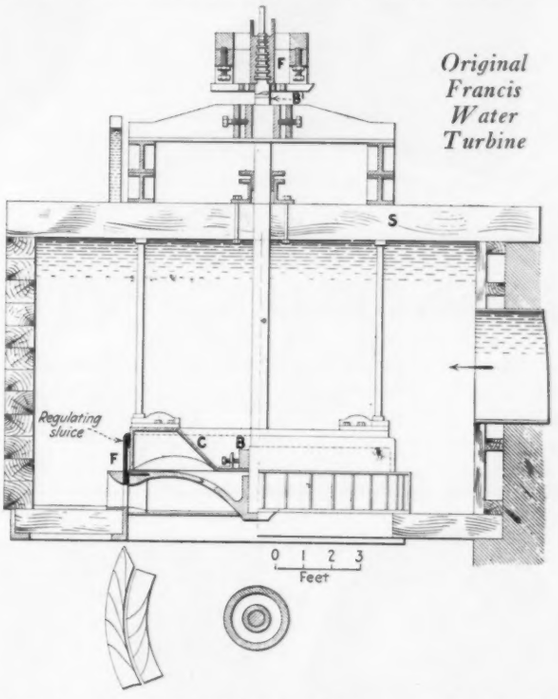
Why New York State Is Behind

8. Compared with the results in California mentioned above, it is disappointing to look at the record of the State of New York during the period between 1895 and today. The State of New York has today in commission about one million horsepower of hydro-electric energy for the use of nine million people, or about one-fourth as much hydro-electric power per capita as is today available in California. The cost of fuel in New York for steam uses in greater than it is in California. The State of New York has more than three million potential hydro-electric horsepower undeveloped within its borders, and its industrial community sadly needs a release from its present annual burden of a steam-power bill more than ninety million dollars in excess of what it would be if the water powers of the state were intelligently developed.

The trouble in New York lies solely in the ignorance of the politicians of all parties that have been sent to Albany. Because of this ignorance no constructive program of development has been possible. The great Empire State, in spite of its many other superior natural advantages, finds that whereas the general population of the United States has increased about 66 per cent in the period from 1895 to 1924, California's population has increased three times as fast as the population of the State of New York, whose increase was about 64 per cent, or 2 per cent less than the average for the whole of the United States. Verily this is expensive ignorance.

Public Versus Private Ownership

9. Another chapter in this history deals with government versus private ownership of our water powers. We had a long ten-year battle in the United States Congress, ending June, 1920, on this question, with the result that when all of the facts presented were finally analyzed the



declaration for well-regulated private ownership won by a large majority, permitting the establishment of the present Federal Power Commission. Fortunately for the public and the engineering profession, the administration of the federal water-power act has been wise and fearless, and up to this time the record of the Federal Power Commission challenges the admiration of every one, even of many of those who were very much opposed to it.

In contradistinction to the plans laid down in the federal water-power act, we have here and there in the past had sporadic attempts to establish government ownership of water powers. The results obtained in the United States and Canada up to date do not justify any further expansion along this line as long as our public utility commissions are administered with the wisdom that now obtains, it is the writer's opinion that public ownership of our water powers in the United States is a dead issue.

Credit to the Engineer

10. The hydro-electric engineer is deserving of some credit for what has been accomplished in the installation today in the United States of more than 10,000,000 hydro-electric horse-power. Hydraulic engineers have written good history in the past and look hopefully to the future. We have been supported in the years gone by the true fascination that pioneer work, far away from paved streets and mahogany desks, always gives to the creative mind. We promise much better work in the future, based upon the lessons of the past, and we welcome from every source all constructive criticism of what we do that comes our way in the future and promise to profit by it.

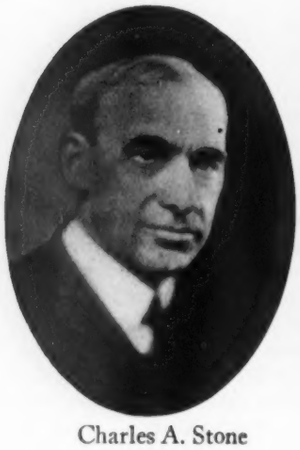
John B. Miller

Samuel Insull

Joseph B. McCall

Master Builders of the Electric Light and Power Industry

Pathfinders who shouldered the burdens of organization, management and finance, and the welding together of great electric generating systems



Charles A. Stone

Henry L. Doherty

Emerson McMillin*

H. M. Byllesby*

Charles L. Edgar

Anthony N. Brady*

S. Z. Mitchell

*Deceased

First Plant of the Niagara Falls Power Company

Its influence upon the generation and distribution of electricity—Imagination and faith of the company's engineers triumphantly stood the test imposed by novel tasks

By Lewis B. Stillwell
Consulting Engineer, New York

THE far-reaching influence of the first plant of the Niagara Falls Power Company was due to a number of causes. The Falls of Niagara were one of the recognized wonders of the world. The men who risked millions in a venture practically without precedent were well-known leaders in American finance. For more than four years before finally deciding what method and machinery should be used they conducted an investigation international in scope and exhaustive in character. Their statement of the problem was broad as the possibilities of science—the utilization of Niagara power on the shafts of turbines or by transmission, mechanical, pneumatic, hydraulic or electric. They interested in the study of their problem many of the leading scientists and engineers of America and Europe. The award of the contract for the first three alternators with switchgear, exciters and meters came at the end of a keen competition between the leading manufacturers of electrical machinery in the United States which had been prolonged for many months. When, therefore, in 1895 the commercial delivery of power began locally and in Buffalo the existence of a new art of vast possibilities in industrial power, in transportation, in lighting and in the broad field of industrial chemistry was widely recognized. It was natural and indeed inevitable that decisions so arrived at and a commercial demonstration of such magnitude on so conspicuous a stage should be widely accepted and adopted.

It may be of interest to consider very briefly what that influence has been. First it must be noted that the engineers of the Niagara Falls Power Company did not create nor, except in one respect, did they even modify the system of polyphase alternating-current production and transmission developed by Westinghouse and his engineers. That system was exhibited comprehensively and in actual operation at the Columbian Exhibition of 1893 before the company made its decision. It was based upon Tesla's United States motor patents issued in 1888. The rotary converter, first patented by Bradley, but independently invented and commercially developed by Lamme and other Westinghouse engineers was an essential feature. If my recollection is correct, C. F. Scott's two-phase-three-phase transformer connection was not shown at Chicago, but it was proposed by the manufacturer and adopted by the company for the Buffalo transmission. In one respect only were the engineers of the company responsible for a change in the electric system proposed and that was in respect to frequency.

The first three turbine units had been contracted for by the company apparently before the relation of speed and frequency had been fully considered, and the turbine speed being 250 revolutions per minute, it became necessary to choose between a sixteen-pole alternator, which meant 33⅓ cycles per second, and a twelve-pole alternator, which meant 25 cycles per second. Ultimately the latter was adopted for Niagara, and it soon became the generally accepted frequency in America for plants in which any large proportion of the delivered power must be converted to direct current for utilization. Whether the change from 30 cycles per second to 25 cycles per second as the standard for low frequency in America was fortunate or otherwise is a question which at this time is purely academic.

While the influence of the Niagara plant upon the fundamental characteristics of the electrical systems now in use was limited to the substitution of a standard frequency of 25 cycles for one of 30 cycles, the demonstration upon a stage so conspicuous of the ability of engineers to design and of manufacturers to construct both electric and hydraulic units far beyond all precedent in power output and attaining in commercial service the results anticipated by theory imparted a tremendous impetus to the development and use of water power. Whereas the larger successful dynamos previously built were of 1,000 hp., here were alternators delivering continuously 5,000 hp. And whereas the largest turbine previously constructed in America was of less than 500 hp. and operated under a head of about 40 ft., here were 2,500-hp. turbines working in pairs on the same shaft under a head of 140 ft.; and here were switches operated by compressed air and capable of connecting and disconnecting at the will of the operator units of 5,000 hp., and a half dozen copper conductors about one-third of an inch in diameter transmitting to the city of Buffalo a larger part of the power used for its lights and street railways.

Test of Imagination and Faith

All this is not very impressive today, but it must be remembered that before 1895 the transmission plants operating in America could be counted on the fingers of one hand and the power transmitted was figured in hundreds of horse power and not in thousands. At the time therefore the Niagara plant made a deep impression by its comparative magnitude as well as by its novel features. Since then we have had a steady increase in the size and power of hydraulic, steam and electric units, but in no case that I recall have the imagination of the engineer and his faith in the sure working of natural law as embodied in his principles of design been tested as were the imagination and the faith of Dr. Coleman Sellers,

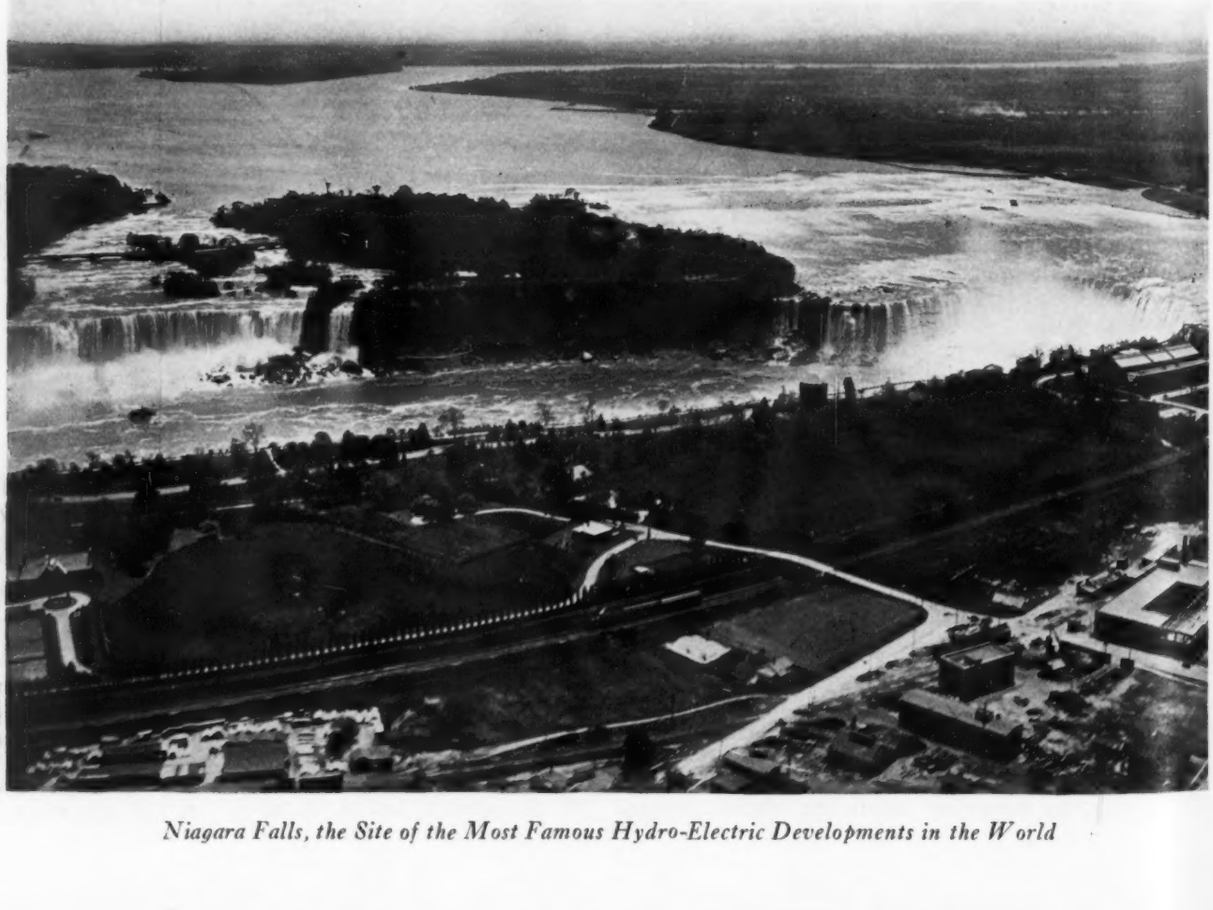
the first chief engineer of the Niagara Falls Power Company, and those responsibly associated with him in the development of Niagara power from 1890 to 1895.

The practical demonstration by the first Niagara plant of the possibility of generating electric power in large units, transmitting that power to distant points and there converting it to direct current was soon influential in promoting a revolution in the method of supplying electricity for lighting and power in our larger cities, where the 220-volt, three-wire Edison system already had established itself. At the Columbian Exhibition a reciprocating engine of about 1,000 hp., designed by John Van Vleck of the New York Edison Company, and directly connected to a direct-current generator was shown, but the dynamos used by the city plants of that day in America were still belt-driven, the so-called "Edison Jumbo" of a few hundred horsepower being among the largest. The able men who directed the development of the business of electric supply in New York, Chicago and other large cities were quick to realize the possibilities of power production by large units installed where coal and water were readily available and the attention of inventors and manufacturers was concentrated upon the production first of large and still larger reciprocating engines and, a few years later, upon steam turbines of great and still greater power. The interconnection of great central stations throughout wide districts of power consumption followed as a matter of course, the reduction in cost of power resulting from increase in load factor, decrease in aggregate reserve capacity and ability to use the less economical plants for peak load only being early realized.

It is, perhaps, unnecessary to point out that in the field of transmission the system of generating and distributing power first demonstrated on a large scale at Niagara is today in practically universal use. Two other results must be credited to the Niagara enterprise so admirably directed in its earlier stages by Edward D. Adams and his associates. Several inventions now in very general, if not universal, use were contributed to the development of the art of electric power production and distribution by engineers of the Niagara Falls Power Company and resulted directly from their study of the problems which presented themselves in the operation of the original plant. Among these were the time-limit circuit breaker, the diagrammatic switchboard control and the Lincoln synchroscope. It is difficult to imagine successful operation without them.

Last, but by no means least, should be mentioned the tremendous results of cheap Niagara power in the field of industrial chemistry. The writer is not competent to discuss this phase of the subject assigned him. It must suffice here to say that Niagara Falls is today the chief center of industrial chemistry in America.

As regards the extent and weight of influence of the Niagara plant upon the general adoption of the polyphase alternating-current system, doubtless considerable difference of opinion are to be expected. Ultimately, no doubt, that system would have come into general use even had the Niagara Falls Power Company never existed. But it may be said with justice that the adoption of the system by that company and its complete success upon a scale at that time very large contributed greatly to the rapid increase in the general use of electric power which began in the last decade of the nineteenth century and now has reached a total of some twenty millions of horsepower in the United States alone. The original Niagara power development is an enduring monument to private initiative working effectively under free institutions in promoting public welfare.

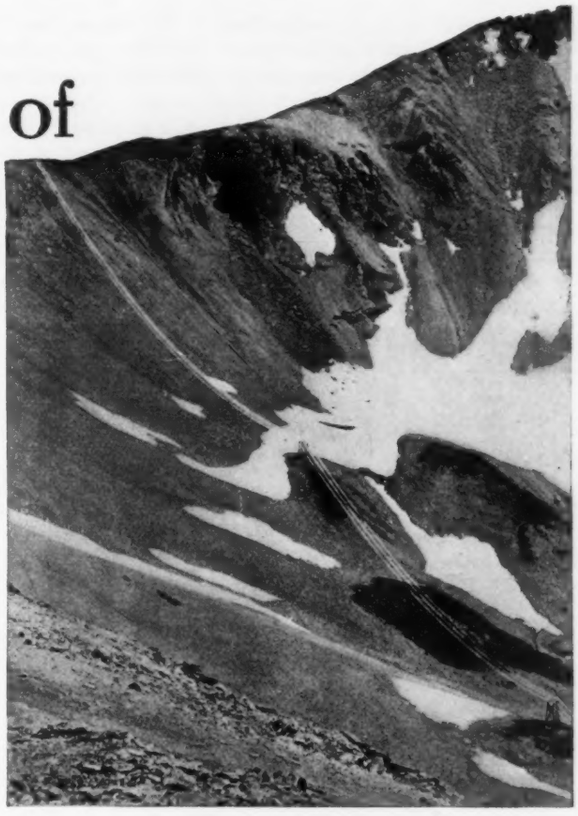


Niagara Falls, the Site of the Most Famous Hydro-Electric Developments in the World

First Half Century of Power Transmission

Its theoretical and practical problems—Development of insulators and towers in combating lightning and corona — How the "Electrical World" and Institute discussions have helped in this progress

By Percy H. Thomas
Consulting Engineer
New York



Transmission Line
Over Camp Bird Divide

THERE is a spice of interest and something of fascination about the beginnings of the development of a new art. The infancy and youth of the art of the electric transmission of power is a conspicuous example. The pioneers in a new art have the opportunity to make startling innovations and revolutionary advances; they may change the impossible to the commonplace. They must use their imagination and foresee coming developments and new opportunities. When an art has matured, however, its progress takes on more the nature of an evolution, a step in advance here and another there, but without marked changes—with a gradual, imperceptible growth which is not noticeable in the growing.

Fifty years has taken the transmission art pretty well through the pioneer stage, although even now from time to time new and fruitful ideas flash out in unexpected directions. Apparently it has not even yet matured. Perhaps no other important field of applied science has developed so completely through sheer intellectual power and scientific and mathematical investigation. Seldom has progress been so free from mistakes or waste. Very few actual installations have been failures and few have been taken out of service, except to meet changed conditions or because they are outgrown.

While no one name is entirely pre-eminent in the first fifty years of electric power transmission, our older engineers will remember many notable men among those who have contributed to the remarkable progress of the last half century—Steinmetz, Stanley, Bedell, Duncan, Scott, Wurts, Perrine, Ryan, Kennelly, Mershon, Bell, Nunn, Stillwell, Ensign, Baum, Lincoln, Faccioli, Buck, Lee, Hewlett, Peek, Skinner, Peck, Creighton and others. These names bring up memories of ardent discussions at Institute meetings, striking differences of opinions, hopes and disappointments. Many phases of the art are represented—mathematical and theory, Bedell, Steinmetz, Kennelly; invention, Stanley, Scott, Wurts; investigation, Ryan, Peek, Kennelly, Mershon; apparatus development, Stanley, Scott, Skinner, Hewlett, Peck; installation and operation, Perrine, Ensign, Nunn, Stillwell, Lincoln, Buck, Lee.

Perhaps the most potent influence of all in the rapid advances of this remarkable period was the habit and practice, existing from the very beginning, of frank exchange of ideas and sincere and keen and critical discussion. Two principal media of publicity served this function—first and foremost, the meetings of the American Institute of Electrical Engineers and its *Transactions;* second, the pages of the ELECTRICAL WORLD. No object of interest, great or small, and no new idea, escaped publicity in either of these places. The National Electric Light Association has contributed much to the more practical side of progress, and the liberal policies of the great electrical manufacturers have been most favorable.

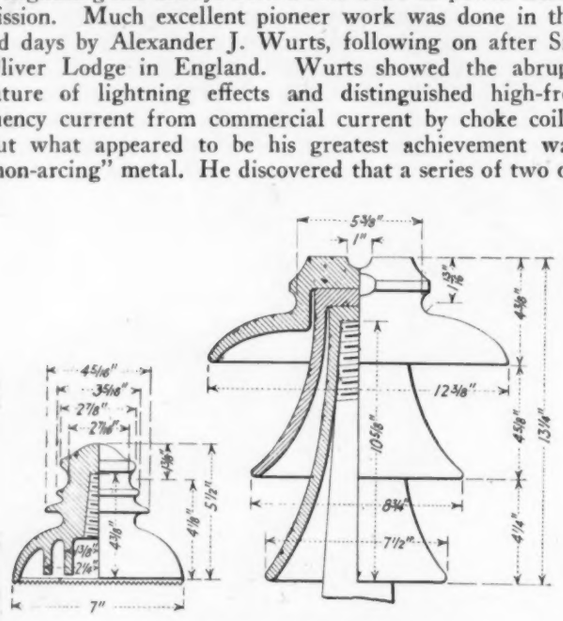
Steps in Transmission Progress

While this is not an appropriate time to list in detail the steps in our progress, the readers of the ELECTRICAL WORLD may be interested in some comments on the work of the early days by one who though not among the earliest comers, has still seen most of the development of electric power transmission, beginning with the time of the old Pamona 10,000-volt transmission line, which had 20-500-volt step-up transformers in series and coils wound of magnet wire without varnish placed in a tank of oil.

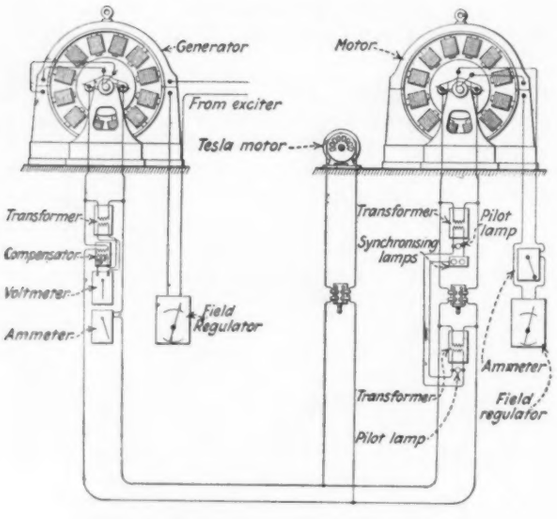
It may seem strange to our younger engineers, but there was a time when the simplest mathematical methods for calculating the performance of a single-phase electric line without capacity were a mystery. A classic exposition by Professor Scott of the peculiarities of inductive drop and the effect of inductive load when combined with incandes-

cent lamps will be found away back in the proceedings of some society. Beddell, Steinmetz, Kennelly and others worked out in the early days the mathematical basis of our present methods of calculation.

Lightning has always been a *bête noire* of power transmission. Much excellent pioneer work was done in the old days by Alexander J. Wurts, following on after Sir Oliver Lodge in England. Wurts showed the abrupt nature of lightning effects and distinguished high-frequency current from commercial current by choke coils. But what appeared to be his greatest achievement was "non-arcing" metal. He discovered that a series of two or



Glass and Porcelain Insulators on Telluride System



Original Synchronous Motor System at Telluride

three brass cylinders separated by air gaps 0.02 in. to 0.03 in. wide, connected across a 1,000-volt generator, would pass lightning and afterward suppress the dynamo arc; but alas! the experiments were made on a generator of a few hundred kilowatts capacity, and when the trial was made on powerful apparatus the metal was no longer non-arcing.

This was the beginning of the realization of the part played in the behavior of apparatus on a short circuit by the capacity of the generator and prime mover to deliver large amounts of power. The distressing disposition of large-capacity apparatus to upset expectations soon made itself felt in all sorts of apparatus in the form of the mechanical injury of coils and windings by the electromagnetic forces. This was earliest manifested at Niagara Falls, where the first great concentration of alternating-current appeared in the circuits of the big 5,000-hp. machines, wrenching heavy transformer coils out of shape and bending solid-bar generator windings, as well as bodily throwing about heavy 2,200-volt cables on short circuit. The same difficulty soon appeared in circuit breakers and still dominates that art, as it does that of lightning-arrester protection.

Development of Insulators

The subject of high-tension insulators for transmission lines has filled many, many pages of discussion. The first insulators grew up from the telegraph art. Glass was soon discarded for porcelain, and then two shells cemented together came in. This was a big step, and now as many as four shells are cemented in one insulator. The development of insulators paused at this point with 66,000-volt to 88,000-volt insulators the practical limit. The lack of mechanical strength of the insulator pin and the difficulty of making larger shells were too great, and for some time engineers did not know what to do next.

Finally, however, Rowe in Mexico and Buck and Hewlett in Schenectady worked out the idea of the suspension insulator. This was a very great step in advance and opened up the way to the practical use of line voltages at least up to 250,000 volts. By this suspension insulator the mechanical stresses were changed from transverse to direct tension, and it thus became possible to use insulators in strings.

For a long time much trouble was experienced from insulator failures and progressive deterioration. The causes remained obscure and much effort was devoted to devising electrical and other tests to detect bad insulators, but with only partial success, for the trouble lay largely in defects in the porcelain, in the burning, in the assembling, the cement and the hardware. These things have been gradually worked out by a process of evolution, and when the testing and replacement of insulators on live lines is generally adopted the insulator situation will be in very satisfactory shape. This does not mean that radical improvements will not be made, for they surely will, but merely that the insulator is not a limiting feature.

An accompanying illustration shows two insulators in general use on 44,000-volt lines in the region of Salt Lake prior to 1910, the smaller being the famous "Provo" glass insulator. Note the long petticoat of the porcelain type insulator as contrasted with the stocky "ball core" types of today.

Wooden and Steel Poles

A second great limitation that blocked development in transmission was the weakness of wooden poles for heavy conductors and long spans and the rapid deterioration of the material. The well-known steel towers, tried out by Buck and Mershon, proved the solution and now offer no impediment but cost to the growth of the art. Many interesting problems in tower design are presented by long spans, tight stringing, clamps, corona, erection, etc., but these are more of the nature of detail and good design than of general interest. Few people realize what a wonderfully efficient structure a transmission tower is and how much useful duty is obtained from an exceeeding small weight of steel.

One advance requiring some imagination and much courage was the use of the high-tension outdoor substation,

which has turned out a great boon to the art. This was first introduced by the Southern Power Company in a district subject to snow and sleet.

Investigation of Corona

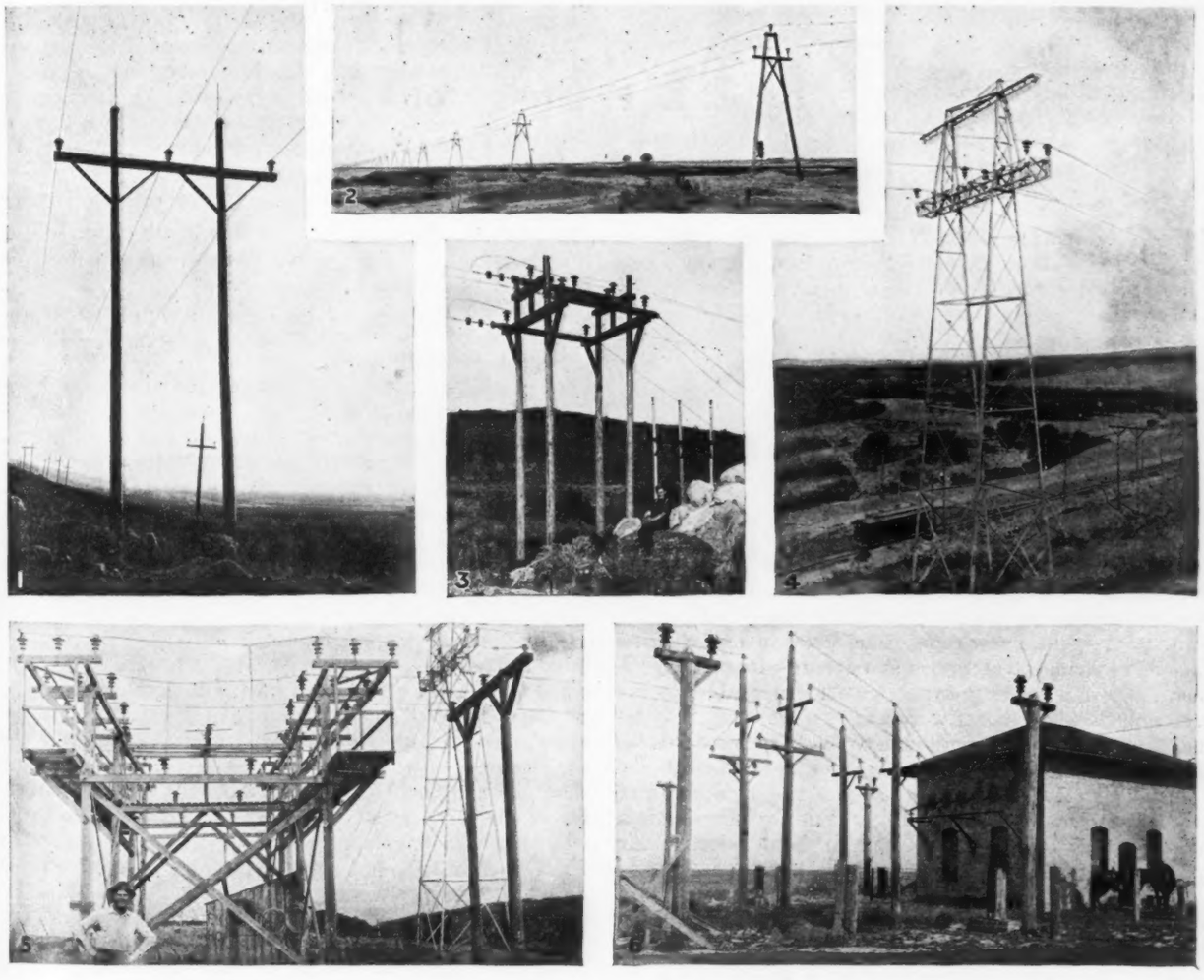
Corona has furnished an opportunity for some most scientific and remarkable work. Recognized in connection with the old Telluride (Cal.) transmission in the early nineties, its nature and approximate behavior were worked out by Scott, Mershon, Converse and Nunn. Mershon's Niagara Falls test was famous and helpful, but only partly conclusive, on account of his difficulty in measuring energy losses in the high-tension circuit. It remained for Peek to give the complete scientific solution, which was later verified by Whitehead and has since met every test in the growth of the art.

Space is not available to tell of the interesting growth of knowledge concerning the electrical performance of the transmission line—first the effect of the electrostatic capacity and charging current, then such questions as double-star transformers, the effects of grounded neutral and harmonics and telephone interference, the long line with distributed inductance and capacity, etc. The calculation of the flow of current in the high-tension network at time of short circuit, with all synchronous and asynchronous apparatus contributing toward the *mêlée,* is a recent and important advance.

One of the last new ideas, and one belonging rather to the coming than the passing epoch, is the practice of "level" voltage operation—that is, maintaining the same voltage at all stations on a transmission line, or, more broadly and more generally useful, the holding of voltage fixed at any one point regardless of load and permitting the flow of power in either direction without disturbing voltage conditions.

As the semi-centennial passes all signs point to a second era of marvelous growth in practical developments and another period of great scientific and intellectual activity in the transmission field.

The goal of the new period may be characterized as universal distribution through high-tension transmission, with the resulting network as the clearing house of electrical energy between those who have power to offer and those who need power for use.



Figs. 1 *to* 4 *Are Early Wooden-Pole and Steel-Tower Transmission Lines Using Glass and Porcelain Pin-Type Insulators on* 44-*Kv. and* 80-*Kv. Lines in the Telluride District. Figs.* 5 *and* 6 *Are Early Switching and Transformer Stations in Utah*

Lightning Protection

From Franklin through Faraday to the aluminum electrolytic arrester—Difficulty of the problem and illusive nature of many discoveries that were apparently successful

By E. E. F. Creighton
Consulting Engineer
General Electric Company

BENJAMIN FRANKLIN started lightning. This momentous occurrence was only one hundred and seventy-five years ago. Franklin noted in his diary on November 7, 1749, twelve similarities between the "electrical fluid" of his laboratory experiments and lightning. Incidentally, it is a great satisfaction from the student's viewpoint that all the indefinite lore of ancient Greek and Egyptian does not have to be searched to gain information on lightning.

In the way of protection against lightning, as contrasted with prevention of formation of thunderclouds, the next "high spot" after Franklin and his lightning rod was generations later when Faraday and Henry were laying the foundations of the stupendous modern electrical developments. Out of this epoch-making work one salient factor is chosen as the most pertinent thing in lightning protection. The knowledge came from an investigation famous in technical literature as Faraday's ice-pail experiment. It might just as well have been the bucket for watering the horse, but it wasn't. From the "cage" experiment in 1836 an important law was deduced: It is impossible to induce an electrostatic charge through the walls of a closed conductor. The practical significance of this law is contained in the advice: Put anything inside a metallic cage to obtain protection from electrostatic induction by thunderclouds.

If this brief survey could cover anything more than a few of the most outstanding factors in lightning phenomena and protection, description would be made of such factors as the mathematical work of Maxwell, the experimental work of Hertz on electric oscillations, the discovery of the electron by J. J. Thomson, and other fundamental matters. Otherwise little of immediate pertinence will be missed if we leap over the decades from Faraday's experiments to the beginning of electrical transmission at the end of the last century. During these unmentioned decades the lightning-rod salesman had got himself in the same nuisance class as the book agent. Nevertheless, the problem of protection against lightning is serious. The difficulties of the problem involve the most recondite information and processes known to pure science. Furthermore, the importance of the problem of lightning-rod protection has been increased by the needs of safe storage of oil, cotton and explosives.

But the greatest impetus to the development of protection against lightning came from the imperative demands of electrical transmission companies at the beginning of this century. Progress in protection has been made, but the developments are yet far from complete and have barely kept pace with the demands. The demands for more protection have grown with the industry and the conditions have been changing—for example, there is greater destructive power in the path of larger generating capacity, and also the greater length of transmission lines, which increases the hazard.

Another feature that has thrown greater duty on lightning arresters in stations is the increase in spark-over voltage caused by porcelain insulators on the line. Traveling waves of higher voltages are thereby held. These surges travel at the velocity of light and quickly reach the station apparatus. In other words, insulators today are being used somewhat less as relief gaps for lightning surges.

The first step in protection is the attempt, exemplified in lightning conductors and lightning arresters, to lead the transient charges quickly and quietly to earth. Failing to accomplish this purpose, the next step is similar to that of the surgeon in amputating a gangrenous leg or arm. On the electrical system it is known as circuit-breaker protection. The injunction is: Disconnect the damaged circuit before the short circuit can "kill" the whole system.

The outstanding factor in circuit-breaker protection is a device consisting of a small cylindrical steel pot for oil in which a disconnecting rod is placed, surrounded by insulated baffles. This circuit breaker, known as the H switch, was invented by E. W. Rice, Jr. The decade of foresight put into it by the inventor will be appreciated by observing the subsequent changes. After a circuit breaker was installed the capacity in generators was multiplied year after year, yet the breaker remained the same. When an accidental short circuit took place this original breaker had to interrupt the greater power augmented by the sum of all the added generators. It suffices to say that it did.

As to the history of lightning-arrester protection, when the writer in 1901 undertook work under the direction of that trio of pioneers, Stanley, Kelly and Chesney, there was little developed along the scientific and practical side of protection against accidental high voltages. Lodge's work on lightning conductors put him in the foremost rank on the theoretical side. A. J. Wurtz had invented the multigap principle. Elihu Thomson had made contributions of several inventions, most notably those involving the electromagnetic blow-out principle. The lamented

Dr. Steinmetz was beginning to take a hand in helping to solve the problems of protection. To select two outstanding elements of his work would be perhaps to choose his presentation of the underlying theory of the multigap arrester, which incidentally applies equally well to a string of insulator disks, and his earnest advocacy of the overhead grounded wire as a preventive measure.

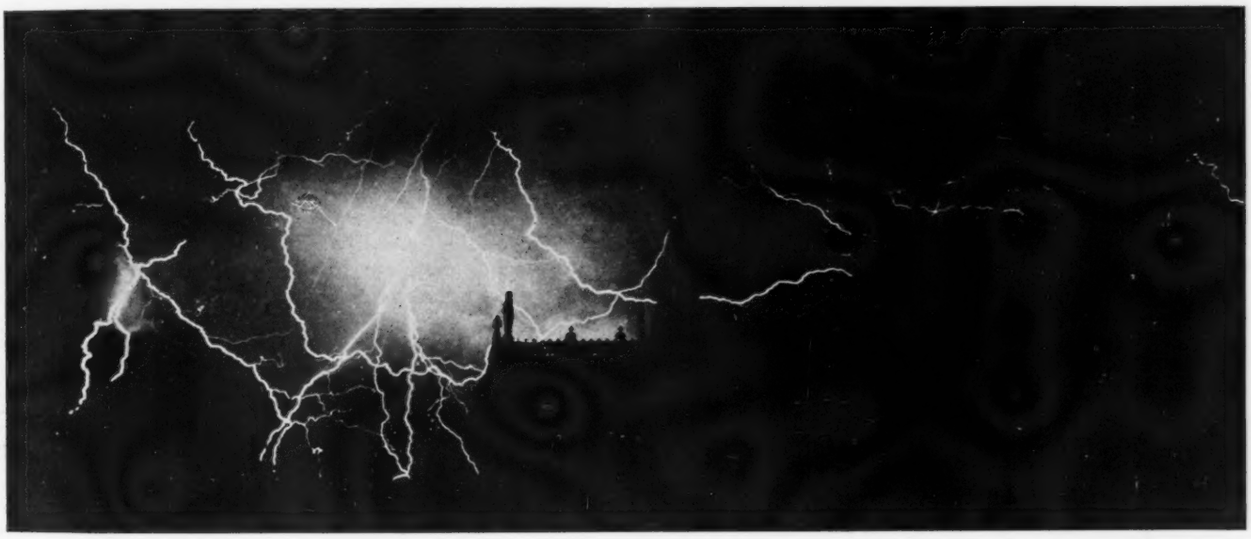
Under the heading "Then and Now" would properly come, as the outstanding feature of lightning-arrester practice in the early years of this century, the well-intentioned gropings of inventors of lightning arresters. For example, an arrester was invented and used in which it was claimed that the lightning was led around until it got dizzy and gently took the path to earth. Another arrester which depended on electrostatic capacity to give protection had no appreciable electrostatic capacity, and when lightning sparked through the circuit of the arrester it short-circuited the generator power. As a remarkable experience a distribution company which used this device gave a glowing report of its protective value during an entire lightning season. The user was sincere, honest and scientific. He was also lucky in regard to the location of thunderstorms during the entire summer. The next year he had to remove all the arresters.

The larger manufacturing companies, by which extensive scientific investigations were carried on, did not escape self-deception in the early days. An arrester would give trouble or apparatus would be lost during a storm. As a consequence an expert would be sent to the installation. The expert would make such alterations in the arrester as his ingenuity suggested. At the end of the lightning season he would get voluntarily a letter of gratitude from the user, stating definitely: "Since you fixed up our arrester we have had no further trouble with it and we have lost no more apparatus from lightning, although we have been through several severe thunderstorms." With a number of such testimonials in hand, could the engineer be blamed for thinking he had fortunately discovered the solution of the problem? Alas and alack! Occasionally there was hardly time for congratulations before adverse reports reversed the conclusions.

Each manufacturing company promulgated its endeavors independently. One year early in this century a company used high resistance and few gaps, while another company used no resistance and many gaps in series. The following year each was independently led to adopt the other's unsuccessful practice.

To review briefly the observations on arresters of all makes and types: Arresters with no solid foundation of principle were used and in spite of their inadequacy received a considerable number of favorable reports from the users. Arresters with a year of perfectly satisfactory operation finally proved unreliable. Slight changes in the installation of arresters, such as turning a unit upside down, produced favorable operation for the rest of the lightning season, and so on. Experiences and information were endlessly confusing.

As a result, the conscientious developers of protective apparatus, with the responsibility of protecting transformers, generators and other equipment, adopted the rule of discounting all favorable reports of operation of lightning arresters. But all reports of unfavorable operation regarding life and protection were accepted. The reports of favorable operation were pigeonholed indefinitely with the understanding that years of experience and thousands of satisfactory installations with no failures attributable to fundamental factors must be the criterion of success.



Flash Lightning One of the Menaces to Transmission Reliability that Engineers Have Had to Combat

A "high spot" in the development of lightning arresters occurred in the laboratory in 1903, when lightning generators were developed and the arresters were tested by new distinctive methods which imitated the effects of the induced charges on the line by lightning clouds.

The one arrester that marks the standard of excellence in electrical protection is the aluminum electrolytic arrester, developed early this century.

How is insulation protected? Protection requires a balance between two factors, namely, the electric strength of the insulation on one side and the relief of the high voltage by the arrester on the other side. Certainly a notable step in the development was taken by W. S. Moody when he reinforced the insulation of the end turns of transformer coils.

In the fifty years of existence of the ELECTRICAL WORLD the first half of its sturdy growth was marked in the lightning field by very little progress; in fact, there was very little need of lightning protection. With the exception of a few notable events, virtually the whole development has taken place in the last twenty years.

Electric Utility Holding Companies

Economic influences of a financial expedient that has made possible the widespread standardization and interconnection which have spelled electrical progress in America and facilitated customer ownership

By A. K. Baylor

Executive Department General Electric Company

MORE than thirty years ago, in the latter eighties and early nineties, the principal competition for lighting and street-railway electrical manufacturing companies in their business found it necessary to participate in financing these enterprises by taking bonds and sometimes stock in payment or part payment for equipment. The practice became so general as to be the rule rather than the exception. It was a necessity at the time, and in spite of the troubles that ensued events have demonstrated that it established a broad foundation on which the electrical industry has developed.

As the financial crisis of 1893 approached the manufacturing companies found themselves embarrassed by these undigested investments, and this condition was an important factor in bringing about the merger of two of the largest and most aggressive competitors—the Edison-General and the Thomson-Houston companies, forming the General Electric Company. One of the first operations was to turn over for cash, much needed as manufacturing working capital by the new combination, the joint accumulation of bonds and other securities of local properties to a separate company organized for the purpose of holding them. This company then proceeded to operate, shut down or dispose of the various subsidiaries. Although organized primarily as a means of liquidation, the working out of this plan demonstrated the practical and economic advantages of group control and operation and became the forerunner of the electrical utility holding-company system.

During the latter nineties and up to about 1910 the formation of these groups was the leading factor in central-station financing. In many cases various properties were taken under control or option by syndicates, including banking interests, for the purpose of molding them into permanent corporate form to support bonds as well as preferred and common stock issues. The term "syndicate" was generally applied to these operations and has to some extent persisted, although the typical holding company with its complete organization for financing, engineering and operating its subsidiaries, with permanent security issues widely distributed and in many cases quoted on the exchanges, is strictly no more a "syndicate" than is any other corporation. "Holding company" is a more correct term.

There have been established more than a hundred of these holding companies—large and small—which now embrace the bulk of the central-station capacity of the country. During recent years the tendency has been not so much the formation of new controlling companies as the acquisition of additional properties by existing organizations and the shifting of properties from one control to another, gradually aligning the various subsidiaries into more logical territorial groupings. The rapidity of electrical development in this country has been due largely to standardization of apparatus and of central-station practice, and in this the holding-company system has been a leading influence.

These facts are emphasized by a comparison of conditions here with those in England and the United Kingdom generally. In the beginnings of the art the British were the leaders. They appreciate the possibilities of electrical service and have fine installations in spots. Still, with most favorable conditions as to population, wealth, manufacturing development, coal supply and condensed territory, they are, electrically, comparatively undeveloped. With them municipal control is quite general—in the majority, in fact—and standard or universal service is virtually impossible.

Comparison with Great Britain

For instance, London has about sixty separate central stations in the metropolitan area, most of them municipal. Practically every borough has its "electricity works," its engineer and committee. The particular care of the engineers seems to have been to have something different, especially with reference to their immediate neighbors, for fear no doubt that the taxpayers of adjoining communities might demand combination in the interest of economy. So London has every character of service, with all conceivable voltages, phases and cycles, with accompanying lack of interchangeability of apparatus and appliances. Several bills have been introduced in Parliament for a superpower station on the lower Thames to supply the London area with cheap and standardized electric service, indemnifying and amortizing the existing small and relatively inefficient plants. Each time these efforts—supported by strong interests—have been defeated by the united opposition of the boroughs.

As municipal funds cannot generally be expended outside the tax areas that support them, many interurban districts are unserved, not being able to sustain independent stations. Manufacturers have been unable to standardize and give the trade through quantity production the benefit of improved products at lower cost, and the holding company groupings as we know them do not exist.

In this country, on the other hand, municipal control is the exception. Central-station practice has been standardized to a high degree, with consequent better and

cheaper apparatus, the resultant economies acting and reacting to stimulate the growth of the industry. The service in every community extends in all directions to its logical markets, overrunning municipal or state boundaries. Adjoining lines are interconnected, power is pooled, our greater development is the result, and the public is the chief beneficiary.

Although freedom from the restraint of municipalization has given to our central-station companies opportunity for national expansion, their development has been greatly stimulated by the holding-company system. It has introduced a diversity factor that strengthens their securities and makes them widely marketable, provides engineering, legal and policy talent of a character otherwise beyond the means of any but the largest centers, and so makes available to the smallest and most remote community electric service of a scope and reliability that could not be locally financed. At the same time, service and policies of controlled properties are standardized.

Holding companies have taken the lead in developing the domestic demand through the establishment of merchandise departments by the various subsidiaries. Central-station companies generally are recognizing the necessity of such departments and their influence on public relations, customer good will (which is reflected largely in the attitude of the home consumer) and the education of the public to become partners in the business. Holding companies, through headquarters supervision, diversity of experience and the combined purchasing power of the local properties, are better able than any single local company to establish this branch of the business on a sound basis—and they are doing so.

Our most striking national characteristic has been industrial development, and nothing has contributed more to stimulate this than the economy and flexibility of electric power. The tendency of the industries has been to cluster around the large centers of population, two of the principal considerations being power supply and a labor market. The rural populations have flocked to the cities, attracted by greater opportunities for employment and better home comforts. Now widespread availability of standard and reliable electric power is tending to establish industrial districts away from the congested centers, and electric service at the same time provides home comforts for the population in every way equal to those attainable in the cities. So we may look for a gradual exodus to the rural districts and the establishment of a more healthy national distribution of population.

There is before the country today no more important economic problem than the interconnection of electrical power distribution lines—the so-called "superpower" system—a movement so vital in the public interest that it has the active and sympathetic support of the federal authorities. The holding companies have contributed more than any other factor to bring about the present favorable condition for nationwide interconnection. The standardization of engineering practice was the first step, the extension of local lines the next, and then the interconnection of the lines of territorial groups of subsidiaries under a single control. Finally follows, as a logical sequence, the interconnection of various group networks as they spread out and approach each other.

Power is now interchanged from the Carolinas south and west to Alabama. In due course interconnection with Virginia, West Virginia, Pennsylvania, New York and New England will doubtless extend this chain to Niagara Falls, the St. Lawrence and the New England States, as well as across the frontier into Canada. Reserve power may be thrown virtually from end to end of the Pacific Coast and from Montana to the Mexican border. Wide areas in the Middle West and Southwest are already interconnected.

These conditions have been brought about largely through the standardizing influence and financial strength arising from group control by holding companies and the natural unification of policy of the leaders in a great industry. They have laid the foundation which makes available this great public benefit years sooner than would have been possible if each local company had continued to develop and operate independently. Indeed, it may be doubted if under these conditions the idea of general interconnection would ever have taken practical form—certainly not without a staggering expenditure to establish the necessary standardization that now fortunately exists. It is impossible to imagine such a condition through a chain of separately operated state or municipal plants, the policies and operating officials subject to the vagaries of local politics. There are those who would subject these activities to federal control and operation, but the direct partnership of the public through stock ownership is an increasing safeguard against that economic folly.

Customer Ownership

Within the last few years the plan of so-called "customer ownership" has been introduced by the electric utility companies, their securities being sold to customers and on installments if desired. The plan took systematic form in 1914. It lagged during the war, but since then has developed so rapidly that in 1923 more than $250,000,000 was invested by individual customers out of a total of $750,000,000 expended for the year in the extension of electric central-station service.

In this customer-ownership movement the holding companies have been the leaders. They have the advantage of financial experience and prestige, and their securities have an established reliability and earning power insured by diversity of service. It is not only unjustifiable but, in the interests of the industry, inexpedient to make any public distribution of securities that does not afford the individual holder an investment safe and profitable beyond question.

Customer ownership is bringing about public ownership in its true form—ownership by the public, each in his own right, as against wasteful and inefficient political ownership and operation, which in practice is absolute dictatorship by one or more public officials depending for tenure of office, not on excellence of service and efficient management of the business, but on political maneuvering.

This movement is destined to have a far-reaching effect, and not only upon the electrical industry. As other industries follow the example there will be built up an increasing number of individual capitalists (i.e., holders of profit-yielding investments), a growing percentage of the whole voting population, who will more and more demand economic soundness in their political representatives. It appears that under our institutions such a condition is the best safeguard against political decay and communism.

Through these agencies working steadily for thirty years, there has developed, naturally, economically and inevitably, a public boon not contemplated or even dreamed of at the outset, and the physical conditions now existing and developing are an increasing safeguard against its curtailment by political interference. An intelligent public, enjoying this boon, will not see it lightly sacrificed, especially as the people are becoming direct financial partners in the companies that serve them.

Some of the many outstanding men who have impressed their personality on the industry and contributed to its upbuilding

1. John F. Gilchrist
2. A. G. Wishon 3. T. McCarter
4. W. S. Barstow
5. Thomas Murray 6. W. A. Layman
7. E. H. Davis
8. Alex Dow 9. W. C. L. Eglin
10. Frank Frueauff*
11. L. Ferguson 12. W. W. Freeman
13. O. D. Young
14. Gano Dunn 15. C. S. Cook
16. H. T. Sands
17. Martin J. Insull 18. A. Williams
19. S. M. Kennedy
20. R. A. Pack 21. Dudley Farrand
22. Ralph Mershon
23. W. McClellan 24. R. H. Ballard

*Deceased

25. Frank W. Smith
26. H. Wagner 27. W. S. Lee
28. J. T. Hutchings
29. M. S. Sloan 30. Guy Tripp
31. George Tidd
32. W. E. Robertson 33. S. Ferguson
34. M. R. Bump
35. W. H. Blood, Jr. 36. F. T. Griffith
37. L. K. Comstock
38. J. W. Lieb 39. J. G. White
40. L. B. Stillwell
41. Walter Johnson 42. Gerard Swope
43. S. G. Dunham*
44. P. Arkwright 45. John A. Britton*
46. W. E. Creed
47. J. J. O'Brien 48. H. W. Buck
49. F. M. Tait
50. John Harper 51. E. M. Herr
52. E. S. Webster
53. C. R. Huntley 54. J. R. Strong
55. Guy Talbot
56. D. L. Huntington 57. J. E. Davidson
58. Farley Osgood
59. T. W. Martin 60. E. W. Rice, Jr.

*Deceased

Important Rôle of Merchandising

Growth of salesmanship in esteem and influence—Keeping the public informed on how it may be served more important than the question of who shall sell electrical appliances

By Arthur Williams

General Commercial Manager
New York Edison Company

ONE of the most interesting of the recent developments in the central-station field is "merchandising," as we now use the term. From the beginning of the industry the merchandising of its product—electrical energy—has been an essential element of its growth. Heretofore, however, the term has been largely confined to the selling of the older consuming devices, fixtures, power equipment and electrical installation. The term was not in general use until the more recent advent of household appliances and their sale by the public utilities.

The response of our central-station organizations to evident public demand for action in this respect has been most gratifying, and many attendant activities have resulted in great good to our entire public utility effort. For example, our display and salesrooms have brought us into an extended and closer contact with our customers and the public; they undoubtedly emphasize the value, not only of preserving a relationship that accords with the best public sentiment, but of encouraging the development in the utility field of representatives who will serve the industry in the broadest and highest sense.

Moreover, this desirable result is not being confined to members of our utility organizations. It is spreading throughout the industry—to manufacturers, agents and dealers—and is having a definite influence upon the contractors who through it find a very much broader field for growth and for public service than has heretofore existed.

It goes without saying that the highest standards of salesmanship existing anywhere should be found in this industry. This means that we must have competent men and women devoting their best effort to the promotion of an ever-increasing use of appliances which uphold the highest standards of stability and efficiency and which give entire satisfaction to our customers. There must be no element of misrepresentation, and there must be nothing in their work which does not conform to high ideals of public service.

From such a point of view, to sell, to merchandise proficiently, becomes as distinct a profession as engineering, medicine or law. In this field one should not only have an intimate and even affectionate acquaintance with the thing to be sold, but there must be an ever-increasing effort to evolve more competence and a more effective personality. As in other professions, the accomplishment of yesterday may well be the stepping stone of something better today. The end need never be in sight.

It is unfortunate that "business" has never been classed as one of the arts or higher professions. Considered as a career, especially by men with college or university training, it has been placed, at least sentimentally and psychologically, on a lower plane than many, if not all, of the professions.

So great is the necessity for the competent, broadly developed commercial man that it is probable his place in the economic life of the country will in future receive a higher degree of recognition, and that the time will come when young men will consider a business career just as desirable an objective, as a result of higher education, as the law, medicine or any other profession. With the further entrance of public utilities into the merchandising field there will naturally follow a growing appreciation of personal representation as a sphere of service.

In the early days of our industry the public came into contact, in a business way, with very few company representatives—and then, as a rule, only with the higher officials. Today, on the contrary, the evolution of business methods necessitates a direct personal contact with every consumer, existing and prospective, not only in industry but also in his home and community life. Where formerly a company's service in light or power was its more especial representative, today, partly from changes in the industry itself and partly from the ever-increasing importance and power of public opinion, the most important representation is human, rather than electrical or technical. Not only must a company itself render a service of the highest attainable standards at the lowest consistent cost, but it must also conduct its relations with its employees, its customers and the public on a plane which at all times and from every standpoint meets the highest public approbation.

Just as electricity has revolutionized the industrial activities of the country, so it is now affecting every phase of our personal daily life, whatever the direction. We are only beginning to appreciate the extent to which this powerful agency for good can aid in improving our standards of living, whether with respect to professional activities, education, recreation, entertainment, home life or civic affairs.

There is a definite obligation resting upon a public utility, as a trustee of public welfare and enjoying valuable public rights, to keep itself in touch, in co-operation, in complete co-ordination with the public it is privileged to serve. One of its important obligations in this respect is to keep the public informed of the thousands of ways in which the utility can render some form of public or individual service. "Merchandising" is one form—one opportunity—for a favorable fulfillment of this obligation. In a sense the methods employed are not so important as the complete attainment of the end in view. Whether the utility shall engage in a merchandising effort directly or shall accomplish the same result through representative and competent agencies is not the essential point, which is that the public shall be kept informed, and informed effectively, of the ways in which the company is "at your service."

Some of our utility companies prefer that local merchandising shall be done by them, under their own auspices. Others take the opposite course of merchandising through outside, independent agencies. Each method has been found effective and has given public satisfaction. Often the method adopted will depend upon an older background of policy which may have had its beginning at a time when no definite choice was necessary or when the many obligations and opportunities of the present day did not exist or were not appreciated. Some of our strongest and best managed companies take the one course, some the other. Which one is taken is not so important as that the obligation be met completely and that the public be served to its entire satisfaction.

Evolution of Rate Making

Three classical papers, two English and one American, have done much to clarify the process—No complete theory has gained general acceptance, but certain principles have

By Alex Dow
President Detroit Edison Company

FIFTY years ago a discussion of rates for electric supply would have been impossible because there was no electric supply. It would not even have been academic, because the idea of a public supply had taken form only in the minds of the few men who in every generation are so far in advance of the times that their contemporaries look upon them as dreamers or as prophets not deserving honor because of the futility of their prophecies. It is true that fifty years ago there were electric lights of a sort, electric arcs of a sort and platinum wires heated to luminosity, but these were all, or almost all, merely repetitions of laboratory experiments.

The development of a practical arc lamp and of a power generator of current for the series-arc lamp which were to change the public ideal of street lighting, and the development of the low-resistance, constant-potential generator, engine-driven, and the high-resistance filament incandescent in a glass bulb, which were to revolutionize interior lighting, came in the decade which began fifty years ago. By the end of that decade the distribution of electricity from central stations, requiring the formulation of rates for electric supply, was an every-day fact.

Forty years ago found electric companies all over the civilized world furnishing street-lighting service with reliable arc lamps at a contract price of so much per lamp per annum, and interior service with similar lamps more ornamentally incased, and even motor service by ingenious motors which were switched into and out of the series circuit which carried the arc lamps. The question of rates had arrived. Some of the factors applicable to rate making had been formulated. Even a meter had been invented which would record the number of hours during which a motor or an arc lamp was in service. It was a clock which ran when the current released its detent and stopped when the current stopped flowing, thereby recording the number of hours during which the connected device was in use.

A Beginning of Rate Making

There was even a beginning of theories of rate making. Dr. John Hopkinson's authoritative study "On the Cost of Electric Supply" was not presented to the world until 1892. But in 1883 he had introduced into drafts of provisional orders giving the parliamentary authority required in Great Britain for the introduction of electric supply a provision for a method of charging which would recognize the variation of cost with load factor. In the second edition, published in 1884, of a book on electricity by John T. Sprague, an English telegraph engineer, I find the warning to those looking toward electricity as a competitor to gas that the interest and capital outlay in an electric plant, and often even the wages for attendants, will be the same for 500 hours' service annually as for 2,000 hours'—a warning which was sorely needed in many later years.

During the decade from 1884 to 1894 the making of electric rates was little influenced by theory. The service was sold on its merits, for what it would bring. The records of these years are of competition with gas lighting and with gas engine and steam motive power, and of strong competition between electric systems (so called), and in either case the electric supply rate was of necessity the highest rate that would obtain the competitive business. My own memories and my old notes when I resurrect these show an endless procession of small central-station enterprises, which, if they succeeded, did so almost in spite of their rate schedules, and if they failed, as was more often the case, did so because their managers could not see the difference between profitable and unprofitable service. An investment in an electric light company was a real "gamble." The action was not so quick as on the green cloth or on the stock exchange, but the result was just as unpredictable, and it was the occasional brilliant winning that kept the players in the game. The solitary and systematic attempt to learn what rates should be was the study and comparison of earnings and costs in detail suggested by Mr. Edison early in the game and carried on by the Edison licensee companies.

In Great Britain, where many of the electric light enterprises were guided by consulting engineers, there was much study of rates after 1890. I have already mentioned Dr. Hopkinson's classic, in which he proved that the total cost of electricity supply could not be correctly stated as so much per unit unless the rate of supplying that unit be also stated—and that with what we now call low load factor the unit cost depends much more upon capital and standing charges than upon the running costs, which continue from hour to hour.

In 1896 Arthur Wright, the engineer-manager of the Brighton plant, presented another classical paper in which he showed from records of his plant that the additional kilowatt-hours delivered to customers during winter evenings were produced at a very slightly increased total cost beyond the costs which had to be incurred to deliver the much less number of kilowatt-hours supplied during summer evenings. He also offered a simple and sufficiently accurate device (since named the demand indicator) for measuring the maximum rate at which supply was called for by the individual customer. Upon this reasoning and this instrument Mr. Wright built up a method of rate making which has flourished until this day.

Students on this side of the water were not lacking. In the ELECTRICAL WORLD for February 29, 1896, there

was printed a paper by W. J. Greene which is also a classic. Mr. Greene presented facts as to the elements of costs, which he had begun to study in 1889 by the analysis of plant records. His analysis of costs was complete. It recognized standing charges, running charges and those expenses affected by the number of consumers which we now call customer costs. He not only proposes but has put into operation a rate method which provides a minimum charge proportional to the investment necessarily made by the company for a customer's service and a sliding scale of discounts serving to reduce the average rate per kilowatt-hour rapidly as the monthly hours of use of demand are increased. Mr. Greene is, so far as I know, the first person to state concisely the basic truth that some such method is necessary to prevent the long-hour consumers being called on to pay the losses caused by the short-hour consumers.

A reading of these three papers will show that by 1896 the analysis of the cost of service was already almost complete. There was recognition of diversity factor and of load factor, for which latter useful expression the industry is indebted to Colonel Crompton. We had begun to speak of customer costs and of demand costs and of costs proportional to the energy metered. The defect of a rate method which encouraged the short-hour consumer by placing part of his costs upon the long-hour consumer had been clearly recognized. The sale of central electric power for continuous use in industries was still a small source of revenue compared with lighting, and the makers of rate schedules looked upon power business as the sale of a by-product. Service was still sold at flat rates—so much per connected lamp per month—or was sold by meter at so much per lamp-hour; but practical and accurate energy meters giving correct readings on dials were on the market, and the use of the kilowatt-hour as the measure of electric service was a matter of law in some localities and a rapidly spreading custom in all localities.

During that decade the fashion of selling service by the kilowatt-hour became almost universal. A special rate was made, of course, for power service, which entailed the use of separate meters for power and lighting on the same premises. The rate theory taking account of load factor was reduced to practice only by a few of the more progressive managements. While experience, costly in many cases, had taught that each and every kilowatt-hour could not be sold safely or competitively at the same rate, the adjustment of rates to costs, if made at all, was made by the establishment of numerous class rates, and by trial and error—instead of by analysis.

In my opinion, the causes which tended most to this delay of correct rate making were, first, the development of the alternating-current watt-hour meter and the enterprise of the manufacturers who sold it to companies theretofore using flat rates, and sold with it the simplest kind of straight-line rate schedules, which, together with the salesman's type of meter, were guaranteed to work wonders toward the improvement of business. And, second, the continuation of the era of destructive competition between electric companies. It was not until the decade beginning in 1904 that the managers of electric light properties, the manufacturers of electrical machinery and the more intelligent leaders of public opinion recognized that our service to the public was hindered and not helped in its growth by local competition. Between 1904 and 1914 this economic truth found wide acceptance, and in the last decade of the fifty years' life of the ELECTRICAL WORLD it has had no authoritative challenge.

When the electric supply managers found themselves—most of them—free from local competition they set themselves to consider ways and means to develop their business, and the effect of correct rate making on gross and net earnings received its long-delayed recognition. Without looking at the files, I am sure that in the last twenty years the ELECTRICAL WORLD has contained in every month at least one useful article dealing with rates. The proceedings of the trade associations both here and abroad have included many such papers. Even the mathematicians of the highly technical societies have exercised their talents on rate problems, so that there has at times been a plague of theory. Some of the most practical and useful studies of rate questions are to be found in the opinions and decisions of state and national public service commissions or courts.

No Complete Accepted Theory

We are far from the general acceptance of any complete theory of rates, but within the industry we are fairly agreed upon important principles. There is still much empirical rate making. I believe that empiricism persists because, after all, the ultimate test of a rate schedule is whether it serves to settle accounts to the satisfaction of both parties. There are lots of rate schedules in which adaptation has been sacrificed to superficial simplicity. Conversely, there are rate schedules which are injuriously complex.

I have wished more than once in the course of my years of service on the rate research committee of the National Electric Light Association that my committee had some such power as was attributed to it by malicious critics, to dictate the making of rates and rate schedules. I would willingly have used that power to prevent the making of cruel and unusual forms of electric rates and to abolish some that I found in existence, and I would with equal willingness have dealt harshly with the manager who was hurting his business by an arbitrary schedule which had no merit except brevity, and wrongfully laying a large share of service costs upon customers who had done little to incur those costs.

Thus far I have talked in terms of cost of service. But our studies of the last twenty years have recognized the element of value of service and the necessary apportionment of the burden of a reasonable profit to different classes of service according to the willingness and ability of each class to earn its share thereof. The immense increase in the use of our energy by industries which heretofore have produced their own electric power and could continue to do so has taught us the value of our service to these industrial consumers. They would not use it unless it paid them to use it. We have also learned the value of that industrial business to our non-industrial customers, who have profited by the reduction of our costs through the increased output which the industrial sales have made possible. The extension of domestic electric service to the smallest households has put us in touch with the ultimate consumer, and in dealing with him we have learned and practiced the economic rule that service to the small consumer will become cheap to him and profitable to the company if every such consumer is served at a rate which encourages him to use our service liberally.

Finally, we have learned that theory is a necessary guide in rate making, but that because rates must be made for the future the analysis of past costs cannot be any more than a guide and that rate making is an art. We have had it preached to us by disciples of John Hopkinson,

who went much further than their teacher, that every kilowatt of reservation required by a customer should earn an identical annual return. We have had overzealous disciples of Arthur Wright preach to us that every kilowatt-hour sold should carry the same margin of profit. We know now that neither the equities nor the expediencies require us to be so meticulously exact. We have learned and lived by the rule that we shall serve every one at such a price that none shall be served at the cost of another and that no one shall be asked to pay us an excessive profit. We know that our own interests as well as public opinion require that we shall serve well the householder and the small merchant or manufacturer who is literally dependent upon us for service.

We have also learned that the large manufacturer and the mercantile magnate who buy our service by preference and not of necessity are alike able and willing to pay us a price which will be profitable both to the buyer and the seller. We have learned that other electric public services, such as street lighting and the supply of motive power to street railways and to railroads, can be and should be combined with our own work because the combination tends to lowest costs for all. The rate schedule which applies all these lessons is the ideal toward which we are progressing, and the progress of the last ten years has been very great.

Manufacturing Then and Now

Reflections on the brief but momentous history of the electrical industry which are startling in what they disclose and what they foreshadow—The past and what it suggests

By W. A. Layman

President Wagner Electric Corporation

IN OBSERVING its semi-centennial anniversary the ELECTRICAL WORLD not alone pauses for a moment to mark significantly a notable milestone in its own career, but in effect observes as well two other significant semi-centennial anniversaries—that of a very large group of the individual leaders of the industry, and also, virtually, that of the whole industry whose valued servant, coadjutor and interpreter it has always been.

What other great industry in world affairs can point to a similar coincidence of its literature, its scientific and commercial inception and development, and the full physical lifetime of a preponderating number of its leading men? Even to those of us whose business years have been completely absorbed in this great industry so striking a fact is startling. How much more startling it must be to those outside the industry who turn from their own affairs for a moment to contemplate the historic panorama which the ELECTRICAL WORLD presents in this anniversary number!

How closely the full life of the industry parallels that of its leaders of today! In every sense the years of its infancy were their years of infancy, its childhood their childhood, its youth their youth, its young manhood their young manhood, and its attainment of stability and broad foundation for the future their middle age of mature judgment and substantial achievement.

Some Startling Reflections

Certain reflections concerning our industry are always startling to me. Let me set down a few.

1. The scientific toys of the children of today were the monumental electrical achievements of our childhood.

In 1878 Count du Moncel, in his "Exposé des Applications de l'Electricité," which was a very complete review of what he termed the electrical art of the day, declared that "The electromotive force is only susceptible of application in very narrow limits, which cannot exceed those of clockwork," and (with reference to the development of electric power motors) that "It is certain that up to the present time no motor has equaled one horsepower, and those who treat the problem as solved recall to us the fable of the hunter who sold the bear's skin before he had killed the bear."

In 1881, at the Paris International Exhibition of Electricity, the transmission of five horsepower of electrical energy three miles with a loss of 50 per cent of the generated energy represented the maximum development of electric power transmission.

2. The elemental lessons in electrical engineering of our high-school boys of today were the staggering unsolved engineering problems of our early manhood.

While I was a college student in electrical and mechanical engineering an international electrical commission was pondering the great problem of how to transmit the power of Niagara Falls to the city of Buffalo. One of the colossal figures of the electrical engineering world, the American promoter of the great transition from direct-current to alternating-current distribution, appeared before this commission and recommended the development of the compressed-air transmission system as the solution of this problem. Yet later his own corporation manufactured and installed the electrical equipment still in operation at the plant of the Niagara Falls Power Company. Upon the tower of our college at about this same time was displayed to public wonder a single electric arc light, then regarded as a startling achievement in electrical progress.

3. The conventional and well-organized operating tasks of our junior public utility and manufacturing executives of today were the heart-breaking creative problems of our own early manhood.

The senior executives of today well remember the days of their creative organization work in the fields of central-station and industrial finance and production. They recall vividly the unreliable and inefficient equipment, the units of small capacity, the reluctance of capital to enter the industry, the restricted range of transmission of current, the comparative insignificance of power load, and all those other difficulties marking the foundation building of a commercial industry. Those problems have passed into history. The junior executives of today find a broad stable foundation beneath them. Theirs is the problem of superstructure with respect to the foundation tasks of their senior officers.

4. Archeology, ancient literature, medieval science and art, the records of our own colonial times, the reminiscences of our fathers, yield us nothing in the form of literature of our commercial industry. Our entire literature is the record of our own lifetime and represents the diaries of our own endeavors and achievements.

Is it not a tremendous boast that the ELECTRICAL WORLD of today can say that it is representative in literature of the entire historic career of an industry soon to outrank all other commercial industries of mankind? What other journal of modern times can claim so great a distinction?

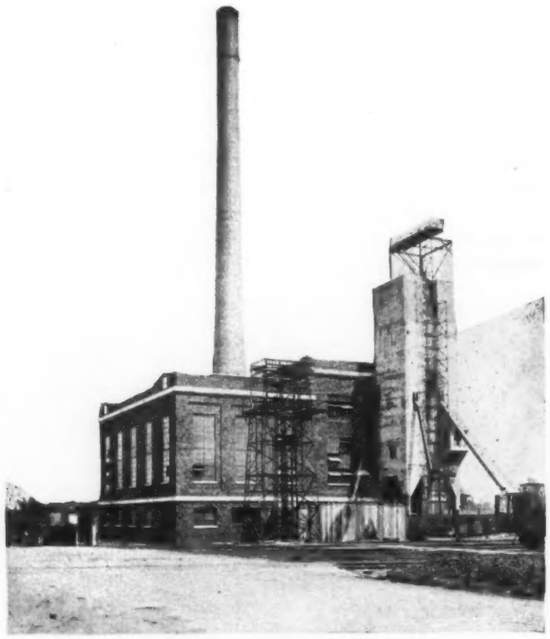
Electrical History Familiar to All

Manufacturing—then and now—how little there is to be said on this theme of interest to the current generation. The majority of living men in the industry know personally its whole history. In their college days their laboratory work was with machines and types of electrical equipment embracing the entire early art of commercial electrical manufacture. They have operated some of the so-called historic dynamos which generated 110-volt direct current and have also operated the motors which consumed this energy after a desultory transmission of a few city blocks. They have gained their elementary knowledge of alternating-current transmission from an actual laboratory operation of some of the first alternating-current generators, transformers and polyphase motors which the factories of our own country and Europe produced. They have experimented with the first telephones and telegraph instruments commercially employed in all the world. They have seen with their own eyes the first single-phase motor of successful commercial construction. They have actually made laboratory measurements with the first electrical measuring instruments manufactured for commercial use.

A survey of manufacturing activities then and now would be superfluous to the electrical fraternity of our time. They know the alpha and omega of it up to date. Perhaps it will suffice to make brief reference to the responsible part the manufacturers have played in the progress of the industry as a whole. In the primitive factories of forty and thirty years ago there was evolved a very considerable proportion of the significant useful devices of the industry. In the intervening years the research laboratories of our manufacturers have not alone evolved the foundation work for the expansion of our commercial apparatus, both in variety and magnitude, but have also conceived and brought into practical use a very large percentage of the discoveries and inventions of this electrical age. This was a natural responsibility. That it was productively discharged need excite no surprise nor elicit extravagant commendation. The responsibility is one the manufacturing fraternity continues to accept and still endeavors successfully to discharge. The public may perhaps look to the workshop for an increasing share of the industry's evolution.

The Impenetrable Future

The ELECTRICAL WORLD has not invited an attempt to penetrate the future. In deep humility I thank the editor that he did not. Bold indeed is the man of current times who attempts to become the Jules Verne of the electrical industry. If within the span of our fifty years the ELECTRICAL WORLD and its readers have seen come into existence an individual electric dynamo of capacity sufficient for all the power and lighting needs of our greatest metropolis as it was in our youth; if we have seen come under the measurable control of man an invisible medium of energy transmission by which a single human individual can transmit his thoughts through space, with the energy equivalent to that of a single incandescent lamp, to an audience of twenty-five million human souls; if we have observed within the span of our lifetime a development of the scientific knowledge of that mysterious thing called electricity from the stage of impenetrable mystery to the plausible demonstration that it is the foundation unit of all matter—what common mortal will be so bold as to attempt definitely to say what the next fifty years has in store in the progress of the science and art with which we are identified? I gladly escape the task, content to comment briefly on our present and our past and reserve for the meditations of my own silent hours groping speculations into our future.



Typical Medium Size Steam Plant

The Story of Motor Control

Modern control systems make motors flexible, automatic, safe and serviceable—Steps in control development in many fields of application—The old and new in control pictured

By A. W. Berresford
Former President
American Institute of Electrical Engineers

BACK of all motor operations in all industry is a control system which guides, controls and safeguards the motors and forces them to modify their characteristics to satisfy the requirements of the work to which they are applied. Little noticed and unobtrusive, controllers are found in every branch of industry, and without them the motors would be helpless and inflexible. The development of controllers and control systems has been rapid and continuous since the early days, and the manufacture of control equipment is an important business in the electrical industry of today.

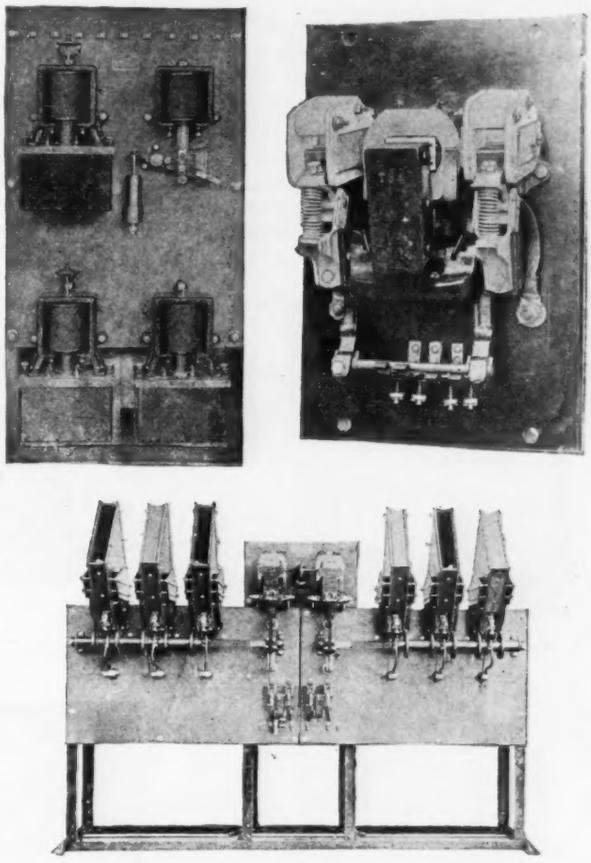
Until 1893-94 such controlling devices as were required for electric power applications were the product of the manufacturer of the apparatus with which they were associated. The first steps had been taken toward utilization of the "controllableness" of the electric motor, as compared with other power mechanisms, in specific applications such as the series-parallel control for railway motors and in the elevator field; but in general the devices employed were of the simplest and devoid of any hint of automatic operation. Not even so elementary a structure as the no-voltage or underload release for starting rheostats had any extended application.

At about this time, however, one manufacturer offered a fairly comprehensive line of field regulators and resistors of special construction, another a line of manually operated starters and speed regulators in varying combinations, and another a line of self-starters sufficient to meet the requirements of the period. From these beginnings came the almost infinite variety of devices now available which make possible the utilization of that outstanding characteristic of flexibility possessed alone by the electric motor and largely responsible for its varied application.

Early Days of Control

The extent of this expansion is evidenced by the listing in the catalog of a single manufacturing company of more than fifteen thousand different types and sizes of device, with probably as many more in short lines, semi-standard or "specificationed" structures in the hands of its salesmen, and the fact that despite this provision of organized structures, their sale no more than equals that of apparatus manufactured to special requirement.

Probably the earliest applications of automatic control



Contactor-Type Controllers

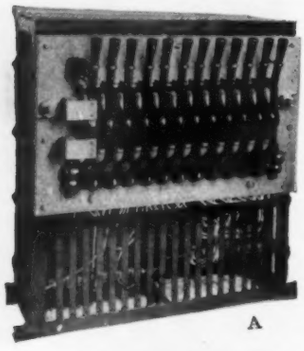
Upper left—Magnetically operated oil breaker and contactors on an early panel. Upper right—Modern alternating-current contactor. Bottom—A 2,300-volt reversing panel using air-break contactors.

were those in which a motor must be started or stopped, depending on the pressure in a receiver or the water level in a tank, through the medium of a self-starter combined with a so-called pressure regulator or float switch. Once the requisite devices were available, these applications presented little difficulty, since the acceleration rate did not vary and dashpots could be adjusted to give the rate required. This was not true, however, in applications where not only acceleration but speed control was involved, or where varying load must be considered in acceleration, or where the safety of human life and limb became a factor. All of these elements were present in elevator operation.

The elevator of the early nineties was hydraulic, even though the pump might be operated by a motor. The desirability of direct electric operation was evident, the problem was one of control, and much of the early effort was expended in its solution. A characteristic structure in use about 1895 consisted of a resistance-containing frame carrying on one side a reverse switch and on the other a series of contacts engaged by an arm which fell by gravity from its top position under the restraint of a dashpot. A shaft operated by rope or lever in the car passed through the structure, carrying on one end the reverse switch and on the other a cam arranged to raise the arm and include all armature resistance at the "off" point. The movement of the cam to its limit resulted in the maximum acceleration rate permitted by the dashpot.

A lower acceleration rate, or operation at lower speed, was obtained by keeping some part of the cam in the path of the arm.

While such structures are typical of the period, specific instances of more advanced practice were in evidence in installations which boldly attacked the (for those days) high-speed office-building elevator problem from the present-day standpoint of car-switch control. A notable instance was a New York installation in which the operation was electric throughout, the controller itself being motor-operated and embodying practically all of the features of acceleration control, speed regulation, dynamic braking and safety provisions now current. Instead, however, of using the winding drum now universally employed in one way or another, hoisting was accomplished as in hydraulic practice by forcing apart two sets of sheaves about which the cable passed. The hydraulic cylinder was replaced by a lead screw driven by the motor and carrying a traveling nut. The unique feature was the interposition of a constant stream of steel balls be-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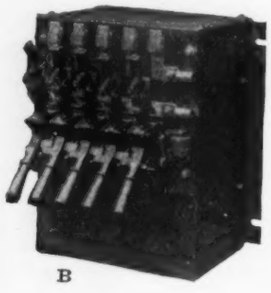
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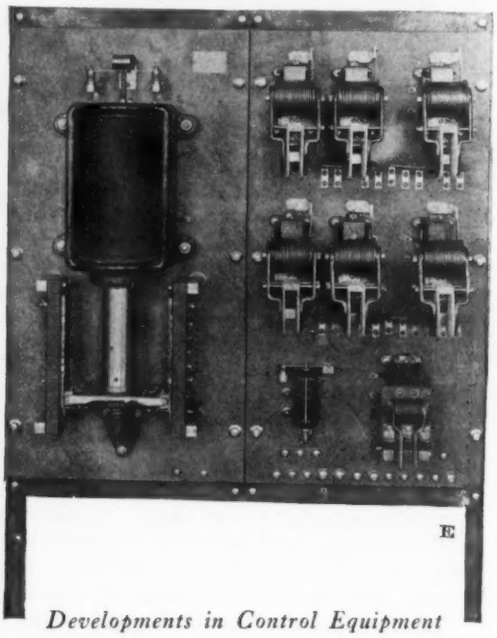
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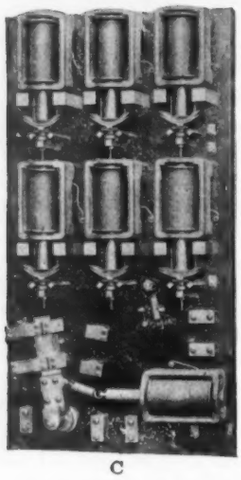
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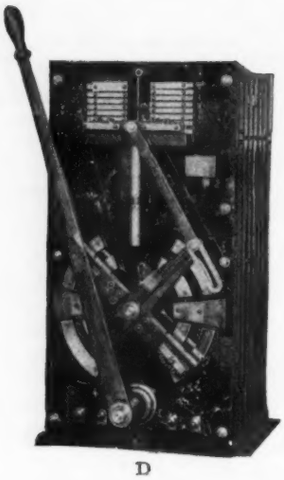
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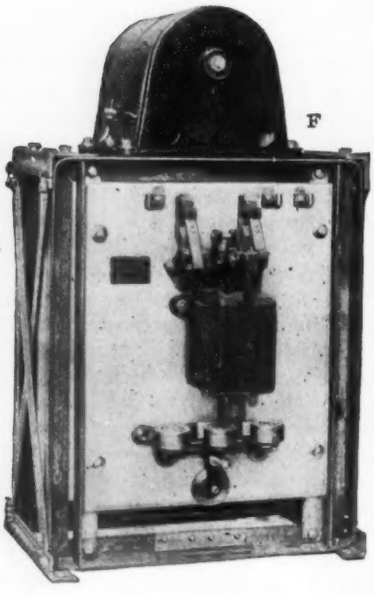
Developments in Control Equipment

A and B—Multiple-switch interlock starters used in 1902 and today. C—Early form of elevator control. D—Crane controller of 1898. E—Dashpot sliding-contact elevator controller of 1909. F—Drum-type reverse switch and single-slip resistance alternating-current elevator control. G—Modern alternating-current elevator controller. H—Modern printing-press controller.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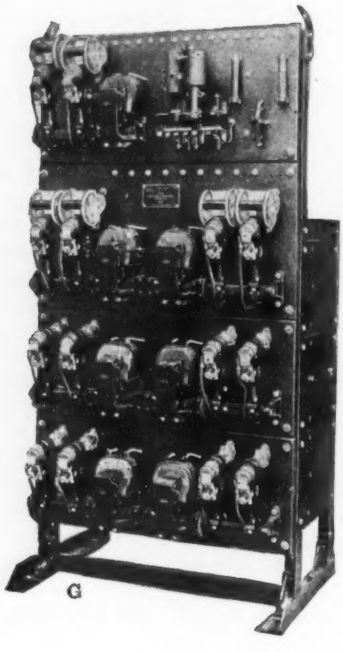
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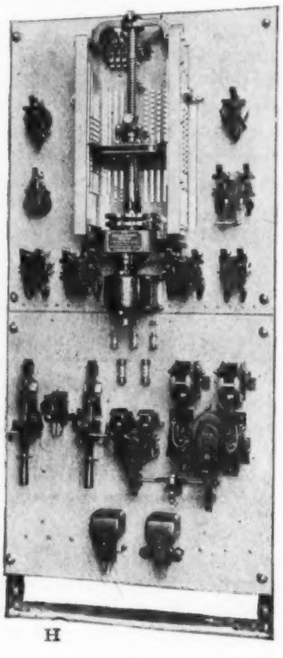
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tween the threads so that the whole mechanism was ball-bearing.

An additional feature of this installation was the use of cast-iron grids for resistance. It was apparently the first appreciation of the valuable qualifications of this material for heavy-current duty of intermittent character, namely, high specific resistance, heat-absorptive as well as heat-radiating capacity, sturdiness and consequent space economy and low cost per watt dissipated.

At about this time also there was installed in the same locality a complete equipment operating on the Ward Leonard system, control being effected by manipulation from the car of the fields of the individual steam-driven generating units.

Counter-Emf. Control System

Following the mechanical structures above mentioned, the next general development was the so-called C.E.M.F. system. In this system a set of switches, which, when closed, short-circuited starting resistance, were so related to a magnet connected across the armature terminals that they responded seriatim to the increasing counter-emf. generated as acceleration proceeded. Additional speed control steps were provided under control of the car switch. This was in essence a variation of the "current-control" method in that the load automatically affected the acceleration rate.

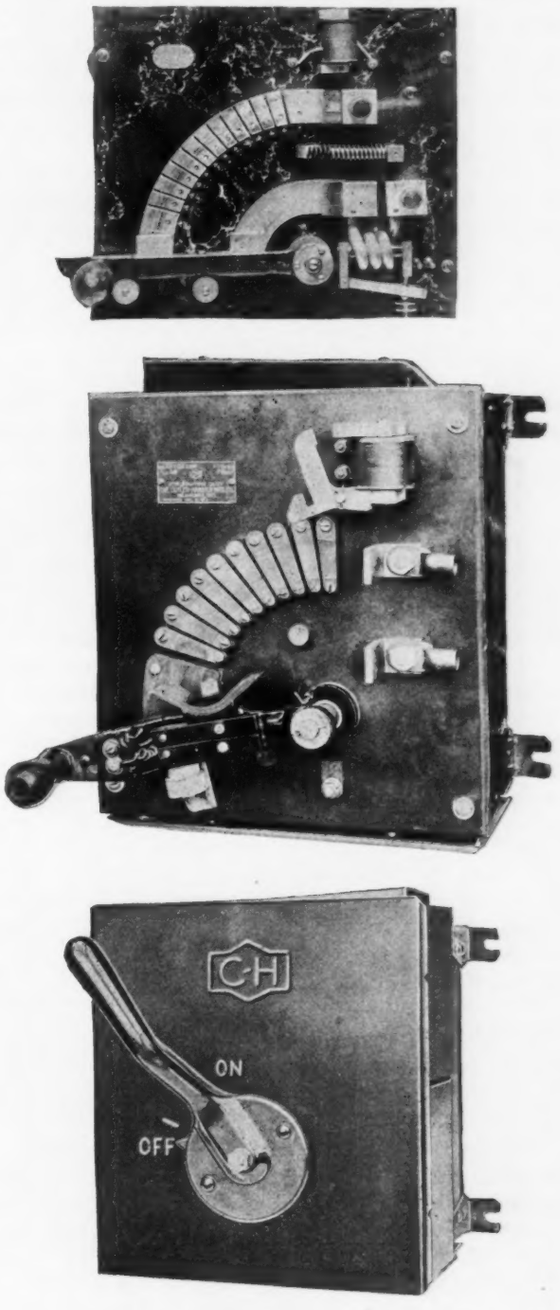
The control engineer now had at his disposal all of the fundamental tools for accelerating, and these are the tools which, with their variants, he is still using in his assemblies. For control engineering and manufacture are in essence the selection and assembly of methods and devices in such relation as economically to perform the desired functions.

Acceleration, however, was not his only problem; he must also decelerate. In comparatively small or infrequently operating installations this was simply accomplished by bridging the armature with a step of resistance; but when the problem became one of 200 hp. or 300 hp. in the hoist motor of an active crane, more was involved. The flashover point in commutation became a factor, as did also the increased internal heating due to the braking current, as well as the need for lowering speeds controllable at the operator's option, but with the interrelation sufficiently foolproof to make accident impossible save through gross carelessness. The mechanical brake could be used only for holding the load when stopped, because of the expense and delay resultant on the rapid wear of the braking surfaces.

The solution was found in the employment of an additional tool—the graduated dynamic brake—in which a series of switches controlled the braking resistance, they themselves being under the control of a series of relays energized by the braking current and consequently keeping it within the predetermined maximum. Under these conditions the operator might throw to the full braking position and the switches would close no more rapidly than would permit the generation of the maximum braking effect permissible. On the other hand, so long as he worked within the maximum, the operator could control at will. Economy in first cost and space occupied was promoted by an ingenious interconnection permitting the use of the same set of switches and resistance for accelerating and decelerating.

The problem of wide speed range for special application was frequently met and solved by varying methods, depending on the values involved. One of these was the Ward Leonard system, in which, in effect, each motor armature is connected to its individual generator, whose field is varied to vary the voltage impressed on the motor armature, the latter running in a field of normal strength. By its employment there was obtained operation at substantially constant speeds in either direction throughout a range of 95 per cent.

A variation, where motor reversal was not required, took current from the line and passed it through the armature of an interposed motor-generator set. At low speeds the motor-generator voltage was subtractive from the line, but as by manipulation its field was reduced to zero, the full line voltage was gradually applied and then by reversing the field the motor-generator voltage became



Development of Manual Starters

Top—A 25-hp. starter of 1898 with no-voltage and overload releases. Center—Modern type of motor starter. Bottom—Modern inclosed motor starter.

additive and finally at full-field strength double-line voltage was applied to the motor armature. Certain steel-mill and hoisting applications in which nice control and wide fluctuation in demand are inherent find their present solution in the Ward Leonard system, its obvious economies being increased through absorption of peak loads by energy stored in flywheels, but the amount and special nature of the apparatus necessary preclude its general use.

An additional method was the "multivoltage system," which found its principal use in machine-tool applications. These supplied to the motor armature a range of fixed voltages varying about 20 per cent and selectable at will through a controller of the drum type. Running speeds between voltage steps were provided by including resistance in the motor-field circuit.

Certain problems, such as the driving of news-sheet rotary presses, paper calenders, etc., required operation at varying speed on two widely separated ranges, the intermediate speeds being unimportant except that smooth acceleration was essential.

These in general were met and still are met by the use of two motors, one of the horsepower essential for full-speed operation and connected for direct drive, the other much smaller and connected through a speed-reducing gear train and a ratchet clutch. The small motor was first started, operating the press at low speed through the threading in and make-ready operations; then by further movement of the controller the large motor was started, and when its speed was such that it tended to drive the press faster than would the small motor, the clutch mechanism overran and the load was automatically transferred to the large motor, and the small one shut down.

For the solution of comparatively simple problems of this kind, where operation at from 7½ to 10 per cent of normal speed was desired, and before the present-day wide-range, adjustable-speed motor was available, the "armature shunt" method of control was frequently employed and with results satisfactory beyond what would be believed possible by the present-day engineer.

This consisted in operating the armature, not only with resistance in series, but with a block of resistance, variable through movement of the lever, shunted across its terminals. The arrangement tended toward constant speed at the low range. The maximum armature current possible was fixed by the series resistance and divided itself between the armature and the shunt. If the armature speed tended to increase, the virtual resistance of the armature increased owing to the increased counter-emf. and a larger fraction of the current was diverted to the shunt and vice versa. This method of control was applied to motors as large as 50 hp., and although obviously reducing the torque deliverable at low speeds, had extended application where this lesser torque was not an adverse factor.

Developments in Alternating-Current Control

All of the foregoing deals with direct current. The advent of the alternating-current motor did not immediately induce a material change, because, curious as it may now seem, the general thought was that no radically new control problems were involved, since its use would be limited to constant-speed applications and essentially continuous operation. After an interval it was realized that if satisfactory automatic devices were provided, the field of distant starting was subject to invasion, and development work began.

The immediate difficulty was the provision of a series of fundamental elements which could be assembled in the relation requisite to the functions to be performed. These must be magnetically operated, and alternating-current does not lend itself readily to magnetic operation. Early structures used direct current for the magnets, but this was obviously begging the question. The first attempts at an adequate solution produced results which made miserable the life of those responsible, and as they continued dispositions previously pleasant underwent a total change.

A magnetically operated structure fundamentally involves a fixed part and a movable part, and when a movable part is introduced into an alternating magnetic circuit the immediate tendency is vibration and consequent noise. Many alternating-current devices hum. These howled. A switch mechanism might close sweetly nine times or ninety and on the next operation deliver a blow comparable only to a power hammer and obviously destructive to the entire supporting structure, including insulation. The devices heated in unexpected and extraordinary places. The contact performance was contrary to and inexplainably apart from direct-current experience, and when the development department had laboriously completed and extensively tested an apparently successful structure and released it for production, the variants introduced by manufacturing processes set up all of the old troubles, but in new places, and the work was begun all over again.

Moreover, the demand for larger structures, with all the niceties of direct-current operation, was becoming pressing. Steel mills were electrified and were installing alternating current exclusively. One boldly specified an equipment for a conveying bridge requiring a 300-hp. hoist motor with other motors in proportion, demanded dynamic braking and magnetic control and made no provision to do the work other than by alternating current. Central-station companies were selling power for industrial use, and contract after contract depended on the possibility of adequate control.

There comes to mind a complete magnetic control for a heavy conveying bridge, the contract for which was taken only after it was believed that the necessary switching mechanisms were at hand. It stood complete on the test-room floor through four months of intensive effort to bring it to what seemed a reasonably satisfactory shipping condition. It was finally shipped in desperation—since all other work was complete and the plant must be operated—but in the hope that with constant expert attention it might be nursed until replacing equipment could be provided. It went into operation and gave satisfactory performance from the beginning and was not again heard from.

Ultimately, as experience was gained, practice crystallized and the economic relations were determined, but the period during which the demand led the supply was enormously difficult. Today there is available for the assembly processes of the control engineer a series of alternating-current elements as complete as those for direct current.

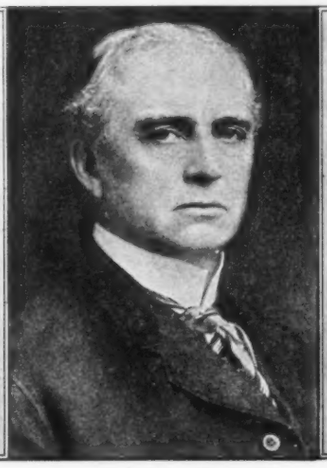
In all of the foregoing there has been only the desire so to present an assortment of facts as to picture the development of the last thirty years. No claim of historical accuracy is made, nor is there any attempt to fix relative importance. The field is so wide and at the same time so detailed that a volume could be written on each of its divisions. It is hoped only that the end sought has been accomplished.

Electrical Chicago of the Seventies and After

Personal recollections concerning the great part played by that city in the art's progress—Home of the oldest of the great manufacturing companies and of the first national electrical society

By William E. Keily
Specialist in Public Utility Relations

General Anson Stager



Enos Barton

Dr. Elisha Gray

SO THE ELECTRICAL WORLD, tracing back to its most remote ancestor, as is the approved custom of genealogists, has arrived at the mature age of fifty! Old enough to know better, one is tempted to say, in moments of irritation, recalling sins of omission and commission. But while one who has been a member of the family may be prepared to admit shortcomings, how much greater is the balance on the credit side of the ledger. What a mass of useful information relating to the science, art and business of electricity the magazine has laid before its readers week by week! And that too in a sphere of activity which expanded so rapidly that books could not keep up with it. The ELECTRICAL WORLD has a right to think that its fiftieth birthday (calculated as before explained) is a matter of some importance.

It has been suggested that something relating to the electrical Chicago of an earlier day might find a place in this anniversary issue. My own electrical recollections, I make haste to proclaim, do not go back quite so far as 1874. It was in 1891 that I first thrust an uncertain foot into electrical journalism. There were then at least five general weekly electrical papers in the United States—the ELECTRICAL WORLD, *Electrical Engineer*, *Electrical Review* and *Electricity* of New York and the *Western Electrician* of Chicago. The names of four of the five are now but memories, for electrical publishing has not escaped the centripetal tendency of modern life.

Competition was of the knife-to-the-hilt order in those days. Advertising, for one thing, was not something prayed over in church; it was the juicy bone of sustenance which all the trained hunting dogs fought for. The days of personal journalism were not over, and the typical publisher professed to believe that every other publisher was a horse thief. He not only suspected it, but on occasion he did not hesitate to air his views in his paper, often with diagrams and illustrations. Times have changed very much for the better in this respect.

In the days of which I am now speaking the electrical industry itself was young, vigorous, "rarin' to go." As a general rule, every manufacturing group fought every other group. Lawsuits, controversies, tricks of the trade (a trade very mysterious to the laity in the early '90s) were the order of the day. "Alternating current" versus "direct current," "high tension" versus "low tension," were battle cries. If you were an alternating-current man, you sneered at direct current, and vice versa. Toleration, study, open-minded investigation might be all right for the dry-as-dust college professors, but the red-blooded young fellows—and it was a young man's occupation in the main—actually at grips in the arena of the electrical business, had no time for such playthings. All old-timers will remember with what glee the direct-current men, in 1890 or thereabouts, made much of the "deadly" character of the alternating current when the

latter was selected for the electrical execution of condemned criminals in New York State. Incidentally, that law gave rise to another deformity to add to the horrors of electrical terminology in the word "electrocution."

But it must not be supposed that there were no amenities. Indeed, with all the "scrapping," there was, in Chicago particularly, a strong esprit de corps. Practically everybody knew everybody else, and generally it was a case where the valiant contenders, "as adversaries do in law, strive mightily, but eat and drink as friends." This was the case, too, with the men on the electrical papers. I remember that during the World's Columbian Exposition of 1893 the then publisher of the ELECTRICAL WORLD, who could be urbanity itself on occasion, took pains to make me the medium for extending warm congratulations on a special World's Fair issue which we *Western Electrician* folks had produced.

It was perhaps a few years after the World's Fair of 1893 that the late J. V. S. Church appeared in Chicago as Western advertising representative for the ELECTRICAL WORLD. Church was a good advertising man and possessed a distinctive personality. He was quite English in his ways, although I think his mother was American-born. He and Frank L. Perry (now living in Baltimore) of the *Western Electrician* illustrated the type of redoubtable opponents who could also "eat and drink as friends." I think that it was Perry who dubbed him "Lord Church"—a nickname that stuck. In chatting with me one day about competition in the electrical magazine field Church said: "It's all in a lifetime, my boy; if there were no battles, there would be no need for soldiers, and we would have no jobs. Perhaps you yourself will be on the ELECTRICAL WORLD some day."

Church's conjecture came true, for later I did have the pleasure and valuable experience of serving for several years, under my greatly valued friend, the late W. D. Weaver, as the associate editor of the ELECTRICAL WORLD in the Chicago office. But if any one had told me in my early *Western Electrician* days that one day I should be associated as a writer with a public utility group, I should hardly have understood what was meant. We heard little of "public utilities" in the early '90s. I suppose the term must have been familiar to economists, but what we young electrical men knew about were the "electric light company," the "electric (or street or interurban) railway company," the "telephone company" and the "gas company." The three first named were all right, but the last was anathema. Gas—pooh!—it was to laugh. But the gas companies have managed to exist, taking their place in that ordered, far-flung ideal and practice of public utility service which is such an indispensable feature of the civilization of today.

Chicago in 1874

The foregoing rambling personal recollections have to do with "early days," which were still much later than 1874. In that year Chicago had a population of about 400,000, and those of its inhabitants who had ever heard of electricity knew it as something used in telegraphing and in a process known as electroplating. In fifty years the community has grown to number 3,000,000 souls and has become a city of cheap electricity, widely applied. Perhaps no other large city exceeds it, in this year of grace 1924, in the extent to which the warp and woof of daily life are permeated by electric service. In 1874, however, the burned areas left by the Great Fire of 1871 had just been rebuilt, and the city, like the rest of the country, still felt the effects of the financial panic of 1873; "electricity" was a word one remembered vaguely as having heard in school, and to the man in the street it was typified by the click of a telegraph instrument.

Later Chicago was destined to become a great electrical center, both as to the manufacture and distribution of electricity itself and as to the manufacture and distribution of electrical machinery and supplies. In 1874, however, all this could not have been foreseen. Still, there were beginnings even then—and beginnings of some consequence too, as one finds on delving into the subject. And there were, of course, electrical men responsible for these beginnings. Three of the most conspicuous in Chicago in 1874 were General Anson Stager, Dr. Elisha Gray and Enos M. Barton, all of whom are now dead.

Mr. Barton, in partnership with George W. Shawk, started a telegraph-instrument repair shop in Cleveland in 1869. Within a year Mr. Shawk sold out his interest to Elisha Gray, and the firm name was changed to Gray & Barton. Afterward General Stager became an equal partner in the firm on condition that the business should be removed to Chicago. This was done in 1870. The little shop began to manufacture as well as repair telegraph instruments, and in 1872 the Western Electric Manufacturing Company was incorporated to take over the business. General Stager was the first president of the company, Mr. Barton being the secretary and later the vice-president. In 1879 the company, with scope much enlarged, was reorganized as the Western Electric Company, General Stager remaining as president until his death in 1885. A year later Mr. Barton became president of the company, retiring in 1908 to become chairman of the board. In 1915 the company was again reorganized, becoming the present Western Electric Company, Inc. Mr. Barton died in 1916. Such is a brief history of the oldest of the three great electrical manufacturing companies of the country, closely identified with Chicago.

Elisha Gray (1835-1901) was a scientist and inventor rather than a business man. His work in telegraphy and telephony was important, and he probably went down to his grave believing that he was the real inventor of the electric speaking telephone. He also invented the telautograph and was president of the International Electrical Congress held in Chicago during the World's Fair of 1893.

From 1869 to 1885 General Stager was the most conspicuous figure in the electrical Chicago of that day. He was a telegraph pioneer, inventor and executive, becoming vice-president of the Western Union Telegraph Company, with headquarters in Chicago. He had a distinguished record as a military telegrapher during the civil war, from which he emerged a brigadier-general by brevet. He was president of the Western Electric Company, as has been related. He was, with the exception of four days while legal matters were being arranged, the first president (1881) of the Chicago Telephone Company, since succeeded by the Illinois Bell Telephone Company, and he continued in that position until his death in 1885. He was the organizer and president of the Western Edison Light Company, chartered in 1882, although negotiations with Mr. Edison were begun early in 1881. Thus he was the leader in the telegraph, electrical manufacturing, telephone and Edison electric light enterprises of his time and place. After his death the Western Edison Light Company was succeeded (1887) by the Chicago Edison Company, the affairs of which were brought to a successful issue by

the late Frank S. Gorton, General Stager's son-in-law. In 1892, by the invitation of the directors, including Mr. Gorton, Samuel Insull became president of the company last named, Mr. Gorton retiring in 1902. It was Samuel Insull who organized the Commonwealth Edison Company, successor of the Chicago Edison Company, in 1907 and built it up to the success all the world knows.

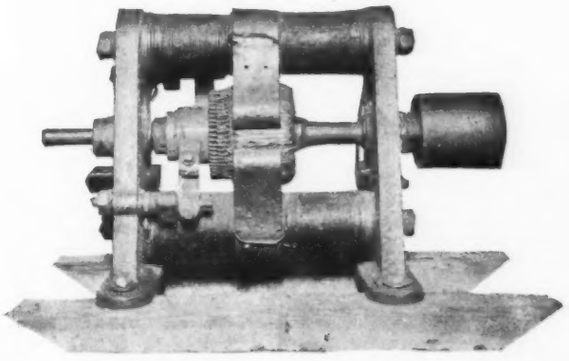
First National Electrical Society

By a coincidence the year 1874 marked not only the birth of the *Operator* in New York, but also that of the American Electrical Society in Chicago, the latter being, I believe, the first national electrical society in the United States. This interesting organization continued in existence until 1880, but appears to have petered out in 1881. Thus it antedated the New York Electrical Society, founded in 1881; the American Institute of Electrical Engineers (1884), the National Electric Light Association and the Association of Edison Illuminating Companies (1885). The society maintained headquarters in Chicago, but in course of time local sections were formed in Chicago, Cleveland, Toledo and Cincinnati. The president of this society, too, was the indefatigable General Stager. Aside from an active membership of note, there were honorary members, including Cyrus W. Field, Joseph Henry, Peter Cooper, Moses G. Farmer, Sir William Thomson (afterward Lord Kelvin), Latimer Clark and others. The society issued its proceedings in book or pamphlet form in a handsomely printed *Journal,* an annual which appeared without exact regularity. Five numbers of this *Journal* are extant, although No. 5 is very rare. The papers, of a general electrical and scientific character, are of a high order, Elisha Gray, Moses G. Farmer, Joseph Henry, Charles F. Brush, Franklin L. Pope, S. P. Langley, H. S. Carhart and others being among the contributors. The minutes for December 11, 1878, contain this reference: "The subject of the electric light was now introduced, and Mr. G. H. Bliss illustrated and explained Edison's method." This must have been one of the earliest descriptions of Edison's experiments in "subdividing the electric light."

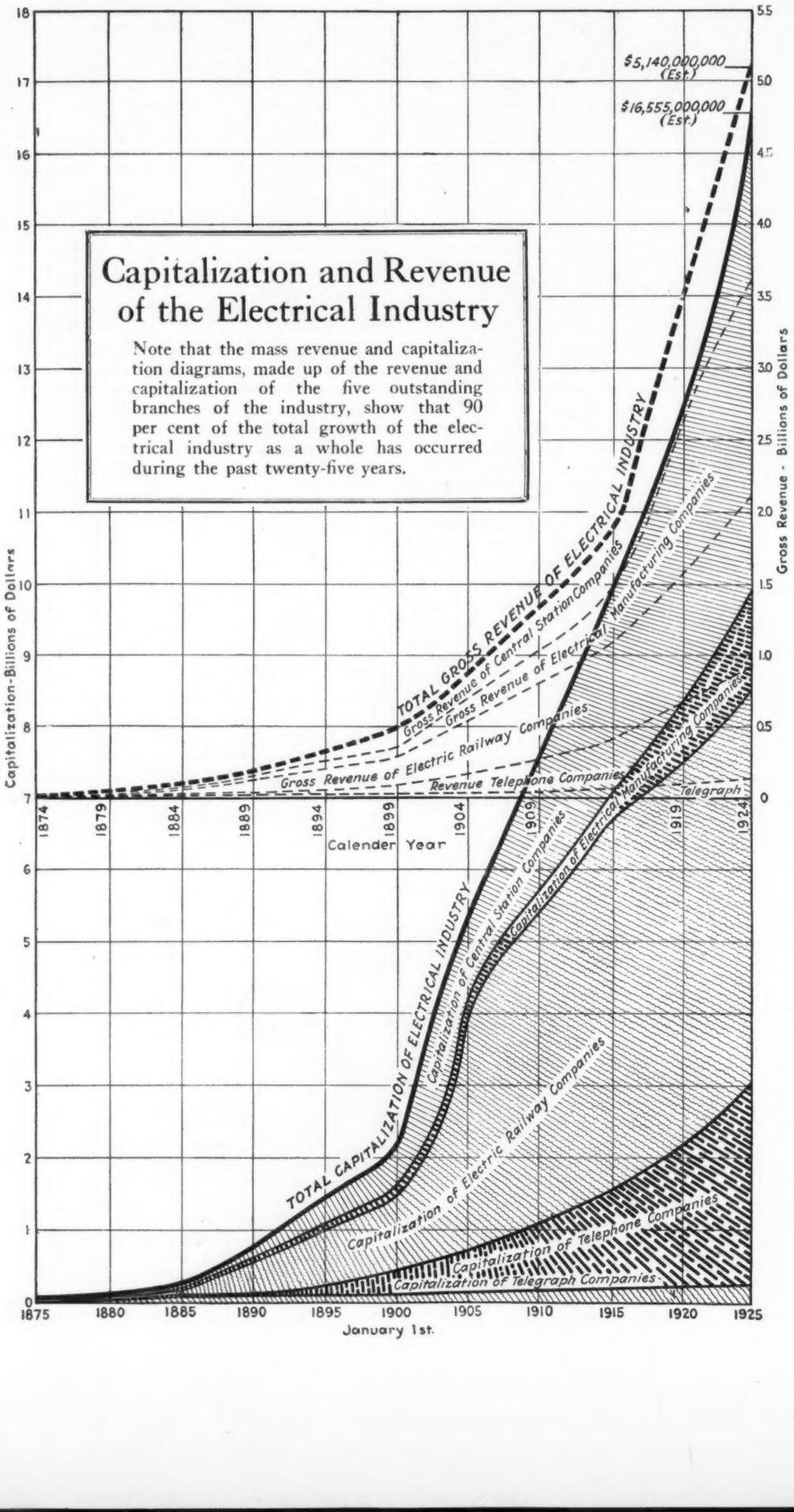
It is not necessary or desirable perhaps—nor, will space permit—to attempt a sketch of electrical development in Chicago in addition to the discursive paragraphs preceding. Many men of diverse talents, in addition to those mentioned, have contributed to the upbuilding of the city in an electrical sense—men like

B. J. Arnold,
F. B. Badt,
Forée Bain,
John P. Barrett,
S. A. Barton,
John I. Beggs,
George H. Bliss,
H. M. Byllesby,
H. S. Carhart,
John M. Clark,
Robert C. Clowry,
J. R. Cravath,
George Cutter,
F. E. Degenhardt,
Lee DeForest,
Alex Dow,
George N. Eastman,
E. B. Ellicott,
Louis A. Ferguson,
C. W Forbrich,
Ernest Freeman,
T. P. Gaylord,
H. B. Gear,
John F. Gilchrist,
J. H. Goehst,
Thomas G. Grier,
A. S. Hibbard,
George A. Hughes,
E. N. Hurley,
Martin J. Insull,
D. C. Jackson,
W. B. Jackson,
B. G. Jamieson,
Peter Junkersfeld,
Milo G. Kellogg,
W. L. Abbott,
W. A. Kreidler,
H. Ward Leonard,
Robert T. Lincoln,
E. W. Lloyd,
W. W. Low,
George A. McKinlock,
K. B. Miller,
R. A. Millikan,
W. S. Monroe,
L. E. Myers,
E. J. Nally,
Ray Palmer,
Charles W. Price,
D. W. Roper,
C. H. Roth,
Frederick Sargent,
Albert Scheible,
R. F. Schuchardt,
Charles E. Scribner,
E. A. Sperry,
Henry B. Stone,
C. H. Summers,
B. E. Sunny,
F. S. Terry,
C. H. Thordarson,
Charles J. Van Depoele,
F. P. Vose,
E. P. Warner,
C. C. Warren,
C. H. Wilmerding,
P. B. Woodworth,
J. G. Wray,
H. W. Young.

Chicago has contributed six presidents to the National Electric Light Association—more than any other city, I believe—and, as the foregoing imperfect list shows, its electrical men, past and present, have been on the first firing line of electrical development during all of the fifty marvelous years over which the ELECTRICAL WORLD now looks in proud retrospect.



Original "Gramme" Series-Wound Dynamo for One Arc Lamp Brought to This Country in 1878 *by John Fritz for the Bethlehem Iron Works*


Capitalization and Revenue of the Electrical Industry
Note that the mass revenue and capitalization diagrams, made up of the revenue and capitalization of the five outstanding branches of the industry, show that 90 per cent of the total growth of the electrical industry as a whole has occurred during the past twenty-five years.
$5,140,000,000 (Est.)
$16,555,000,000 (Est.)
TOTAL GROSS REVENUE OF ELECTRICAL INDUSTRY
Gross Revenue of Central Station Companies
Gross Revenue of Electrical Manufacturing Companies
Gross Revenue of Electric Railway Companies
Revenue Telephone Companies
Telegraph
TOTAL CAPITALIZATION OF ELECTRICAL INDUSTRY
Capitalization of Central Station Companies
Capitalization of Electrical Manufacturing Companies
Capitalization of Electric Railway Companies
Capitalization of Telephone Companies
Capitalization of Telegraph Companies
Capitalization-Billions of Dollars
Gross Revenue - Billions of Dollars
Calender Year
January 1st.
1874
1879
1884
1889
1894
1899
1904
1909
1919
1924
1875
1880
1885
1890
1895
1900
1905
1910
1915
1920
1925

What Leading Men of the Industry Think of the "Electrical World"

On the occasion of the fiftieth anniversary of the ELECTRICAL WORLD readers have been kind enough to send letters of appreciation in which they commend certain features of editorial service. These letters tell the story of the accomplishments of the paper so well that it is to be regretted that more of them could not here be printed. It is possible to publish excerpts from a few only of the hundreds received. While many have been lavish in their praise, no attempt has been made to sort out the most flattering. Put together, the letters make a mosaic of priceless worth, and the ELECTRICAL WORLD acknowledges with thanks the expressions of felicitation and good will.

Mr. Edison's Congratulations

AS A BYSTANDER in the electrical field for over fifty years I have noted the wonderful progress made by the ELECTRICAL WORLD during that period and beg to extend my most hearty congratulations on the splendid achievement which has brought the publication to its present pinnacle of success. May your jubilee be one of the bright spots which shall mark your continued progress onward and upward to still further achievement!

THOS. A. EDISON

"Leader in Its Field"

I HAVE been a reader of the ELECTRICAL WORLD for a great many years and during all that time have known it only as the leader in its field. The mere fact that it is celebrating its fiftieth anniversary and is at present the only weekly publication in this country devoted to our great electrical industry is of itself a mute tribute to its excellence.

Growth, after all, is an expression of efficiency, and the continued growth of the electrical industry and of its leading publication would not have been possible were it not for that efficiency of performance and soundness of policy which command the confidence and good will of the public. Not many industries are blest with such far-sighted and capable exponents and interpreters as the electrical, and chief among them is the ELECTRICAL WORLD. Congratulations and best wishes for another half century of constructive work.

GERARD SWOPE
President General Electric Company
N. Y. City

The House Organ of the Industry

IT IS proper that the electric light and power industry acknowledge, on the ELECTRICAL WORLD'S fiftieth anniversary, gratitude for that publication's long friendship and appreciation for its great service. The loyalty and sincerity of the ELECTRICAL WORLD in the industry's early and more difficult days made the pioneers of the business its debtors, and succeeding generations should own the obligation proudly. The energy and enthusiasm it has constantly evinced in practical and constructive aid to electric light and power workers makes it indisputably the house organ of the industry.

MARTIN J. INSULL
President Middle West Utilities Company
Chicago, Ill.

Fingers Ever on Pulse of the Industry

THE ELECTRICAL WORLD to me is a constant revelation. Its fingers seem to be ever on the pulse of the industry, for very little escapes its attention. The service it renders in gathering and interpreting statistics, in keeping the industry informed on the latest and best engineering and operating practices, and in defending it against unjust and unwarranted attack, is most praiseworthy.

For counsel and unbiased advice the industry has no better or more loyal friend. Too much credit cannot be given the ELECTRICAL WORLD for its aid in obtaining reasonable water-power legislation and for the high ideals of service and the opportunities for further development which it holds constantly before the electric light and power industry.

S. Z. MITCHELL
President Electric Bond & Share Company
New York City

Indispensable Part of Equipment

I HAVE never thought of the ELECTRICAL WORLD as having any age. It was getting nicely under way as the leading publication in the electrical field when central stations had their beginning and has progressed so steadily in its development that I, for one, regard it as practically an indispensable part of my business equipment. In extending my congratulations I want to express my appreciation of the ELECTRICAL WORLD as our foremost publication in the central-station field, for its policy of comprehensive news service, exhaustive treatment of technical matters and its generally clear and accurate statements of facts.

C. L. EDGAR
President Edison Electric Illuminating Company of Boston
Boston, Mass.

"Typical of the Electrical Industry"

THE ELECTRICAL WORLD has been a most useful adjunct in the development of the electrical industry and it has been a source of inspiration in advancing its ideals and stimulating its engineering development. I know of no other publication which has furnished so complete and useful a cross-section of the progress of an industry as your paper. It has afforded to the men engaged in the business and commercial development, as well as to those engaged in the technical phases of the business, a comprehensive and ready means of keeping themselves informed as to the improvement and changes that are taking place in the state of the art throughout the world.

The ELECTRICAL WORLD is indeed typical of the electrical industry itself, and its progressive policies and effective presentation of the technical news are a monument to the journalistic capacity and technical ability of the able staff whose co-operation you have enjoyed. The perusal of its advertising columns, which I have made it a regular practice to scan from time to time, is of distinct informative value and affords a most useful picture of the new types of apparatus appearing in the market, disclosing in striking form the latest products of the progressive electrical manufacturing industries.

J. W. LIEB
Vice-President
New York Edison Company

"Four-Square for Sound Practice"

THE fiftieth anniversary of the establishing of the ELECTRICAL WORLD is a most interesting and important event to every one in the electrical industry. Ever since I have been connected with the central-station industry, which is not so many years short of the life of your admirable publication, I have known of and admired the ELECTRICAL WORLD and have appreciated the great work which it has done for all sections of the industry—year in and year out.

It has always stood four-square for sound practice, just in its policies to producers, distributors and consumers of electrical products. You have done a great work for us all.

W. H. JOHNSON
President Philadelphia Electric Company
Philadelphia, Pa.

Its Name Symbolic of Its Service

THE publication is indeed well named. It is the ELECTRICAL WORLD. Everything that has transpired in the development and growth of the electrical industry is contained in its pages. Every achievement, ambition, application has been recorded. Its editorials have held out visions of new goals to be attained, have warned of possible dangers, have encouraged and stimulated alike the central-station operator, the manufacturer and the engineer. It has been the adviser and leader in many movements for extending the benefits of electricity into new fields.

As a constant reader of its pages for over thirty years, I can testify to my indebtedness to it. Many times I have found in its columns helpful information and data, possibly an entire article bearing directly upon some problem of the moment. Just what the electrical industry would be without the ELECTRICAL WORLD, I am unable to conceive. To me it seems to be part and parcel of the industry.

O. B. COLDWELL
Vice-President
Portland Electric Power Company
Portland, Ore.

Reading It a Necessary Routine

IF ONE attempted to analyze all of the benefits that have been imparted by the ELECTRICAL WORLD it would be necessary to make an extended study in many directions. During the twenty-five years that I have been associated with the electrical industry a weekly reading of the ELECTRICAL WORLD has been considered as a necessary routine in my life. I have gained most valuable and interesting information from the editorial columns and pages dealing with the development and news of the electrical industry, and also from the pages containing advertising; and as I look back it seems to me that it has been essential to my career. I recall having enthusiastically written previous editors about my interest in reading your columns and how very helpful they were to me.

J. E. DAVIDSON
Vice-President and General Manager
Nebraska Power Company
Omaha, Neb.

"Unique Position Long Held"

THE ELECTRICAL WORLD has been to me a guide or mentor ever since my days in college in the "middle nineties," and I take great pride in the fact that even then I kept copies of the paper, so that our bound set begins with the copy of the paper I subscribed for in my senior year at Yale. Throughout its long life I think the editorial policy of the ELECTRICAL WORLD has been remarkably fair and unbiased. It has led the way for development of the electrical sciences and electrical industry without fear or favor. I feel it can safely be said that no other electrical magazine throughout the world approaches the unique position so long held by the ELECTRICAL WORLD.

R. C. LANPHIER
General Manager
Sangamo Electric Company
Springfield, Ill.

Its Value to Pacific Northwest

THROUGH its collection and publication of news of the electrical industry, and particularly its complete and timely articles on the very latest developments in the Eastern States, the ELECTRICAL WORLD has been of great value to light and power officials and engineers in the Pacific Northwest. Inquiry among our engineers and operators indicates that there is no other medium as effective in informing the Western engineer of these new developments as yours. One of them said: "We are pioneering here in this western country, and the information, particularly the technical articles, keeps us in close touch with the new developments in the East, where the industry is more advanced." Another has asserted that the ELECTRICAL WORLD gives in every issue an outstanding service as a textbook or reference book which can easily be card-indexed for every day use. These impressions are characteristic of the feeling that the magazine supplies to the industry most complete and timely reports of advanced developments.

D. L. HUNTINGTON
President Washington Water Power Company
Spokane, Wash.

Its Assistance Greatly Appreciated

AS ONE of the pioneers in the electrical industry I can appreciate the great changes that have taken place not only in the conducting of the electrical business but also in the progress of the industry, and there has been no medium that has done so much to spread this information to the world as the ELECTRICAL WORLD. It has become a standard publication, and the technical and practical matter that has come out of it has been of incalculable benefit to the entire electrical fraternity. This testimonial comes from one who has been in the central-station industry for the past thirty years, and this expression is from the heart of one who appreciates the advantages of such assistance.

D. L. GASKILL
Secretary Ohio Electric Light Association
Greenville, Ohio

Complete History of Development and Progress

THERE is to be found in its issues matter of great value to individuals engaged in some particular field of activity, whether it be design, operation, merchandising or management, and while each individual is naturally more vitally interested in those articles relating to his specialty, yet the educational value of the other subjects treated makes one scan each issue carefully.

I believe that the files of the ELECTRICAL WORLD are the most complete history of the development and progress of the industry in its composite technical, commercial, economic and legal aspects, and to have performed so vast a task in so great a measure reflects no mean credit upon those who have been engaged therein.

H. L. WALLAU
Cleveland Electric Illuminating Company
Cleveland, Ohio

Its Suggestions Make for Success

IF ONE has carefully read every word of the ELECTRICAL WORLD since he has been in business and practiced what it preached, he should have made a success. I personally have conscientiously read it for thirty-one years.

ARTHUR B. LISLE
General Manager
Narragansett Electric Lighting Company
Providence, R. I.

Has Rendered a Lasting Service

I AM SURE that the ELECTRICAL WORLD and its staff will receive many congratulations and many compliments because of its record and the service it has rendered for many years to the electrical industry.

B. C. COBB
Hodenpyl, Hardy & Company
New York

Up to Date and Comprehensive Record

FOR a great many years the ELECTRICAL WORLD has been closely identified with the growth and progress of the electrical industry, and its pages have been an up-to-date and comprehensive record of technical and operating development. They provide an authentic history of the industry from its beginning. The paper has shown a striking appreciation of the main issues and has keenly sensed the problems of the industry as a whole, giving the magazine a position that is commanding and unique.

GEORGE A. HUGHES
President Edison Electric Appliance Company, Inc.
Chicago, Ill.

Admires Its Fearless Editorial Policy

AS A CONTINUOUS subscriber to and reader of the ELECTRICAL WORLD since 1896 I can commend its faithful, accurate and unbiased reporting of developments in the electrical field. When the daily press has carried some startling and at times revolutionary accounts of a new invention, we have withheld judgment until the ELECTRICAL WORLD has presented the facts. In its editorial policy it has struck from the shoulder fearlessly. An outstanding service to those of us engaged in the central-station business is the publication of data on output, earnings and expenses of that important branch of the industry. These curves and the figures supporting them are read with great interest and serve as a yardstick in measuring the possibilities of our business.

W. N. RYERSON
Day & Zimmermann, Inc.
Philadelphia, Pa.

The "Electrical World" and the Water-Power Act

IN securing the passage through Congress of legislation establishing a national policy with respect to a matter of such importance as the water-power resources of the United States, much educational work was required. It was necessary not only to present information to legislators, but also to create an informed public opinion. In this work the ELECTRICAL WORLD took an active and important part, approaching the whole question from the standpoint of securing what in its judgment appeared to be the best methods for protecting both producer and consumer and for securing the most widespread electric service at the least cost. The efforts of the ELECTRICAL WORLD undoubtedy helped to bring about the final settlement of the long dispute which ended in the passage of the federal water-power act.

The successful administration of our national water-power policy requires that extensive and accurate information concerning the water-power industry and its related interests be available to those who administer the policy and that a medium be available for interpreting the administrator and the user each to the other. The ELECTRICAL WORLD has been a most valuable source of information to the commission and to its staff; but of even more value has been its service in making known to the electrical industry and to the engineering world the details of the problems which the commission has been meeting and the manner in which it is endeavoring to solve them. As a continued interpreter of the work of the commission, as a source of information for its purposes, and as a sympathetic critic of its administration, the ELECTRICAL WORLD can continue to be of great value in helping to secure a still greater development of electrical energy and a still better execution of the policies expressed in the federal water-power act.

O. C. MERRILL
Executive Secretary Federal Power Commission
Washington, D. C.

Noted for Accuracy and Reliability

I HAVE been a constant reader of the ELECTRICAL WORLD for nearly twenty of its fifty years. First as a college student I discovered that the ELECTRICAL WORLD was indispensable for keeping informed on the latest developments in the electrical field. Later in business life I have learned to appreciate the ELECTRICAL WORLD not only as a good technical paper but as a paper giving very reliable and accurate news of the electrical industry. Every one in the industry is familiar with the many movements for the good of the industry in which the ELECTRICAL WORLD has taken a leading part, many of which it has sponsored from the beginning.

In the controversies which have occasionally come up in the industry I have always felt (regardless of my personal opinion in the matter) that the opinion expressed in the ELECTRICAL WORLD was sincere and in no way prejudiced or influenced by any ulterior motive. The paper is truly the "voice of the industry."

CHARLES F. NORTON
Vice-President and General Manager
Howell Electric Motors Company
Howell, Mich.

Clear and Prophetic Vision

TO A MAN who, like the writer, has read and studied the pages of the ELECTRICAL WORLD for a period of twenty-three years, during which time he has been closely identified with the central-station business, it is natural, when thinking over what has occurred during these years, to come to the conclusion that the ELECTRICAL WORLD has been of inestimable value to the industry for the three outstanding reasons briefly outlined below:

VISION.—It is apparent that James H. McGraw and his associates were able to look down the years ahead—to gaze over a period containing no paths which were previously trodden and peer into the future, thus visualizing progress and developments which did not have the backing of previous experience. Time has demonstrated that the vision of these men was marvelously clear and wonderfully prophetic. Solomon has said, "Where there is no vision the people perish." On the other hand, where there is a vision of the right sort the people prosper, and much of the prosperity of the electrical industry today may be attributed to the keen foresight of the men responsible for the ELECTRICAL WORLD.

CONFIDENCE.—In the development of the electrical business during the past fifty years there have been many evolutions and changes as the outcome of experience. New ground had to be broken in unknown fields, and whether it was in the construction of equipment, in the engineering features of operation, or in the upbuilding of the commercial departments and creating a revenue, large sums of money had to be raised and expended. Quite naturally the confidence displayed by the ELECTRICAL WORLD gave operators courage and backing with which to go ahead.

STABILITY.—As a factor in stabilizing the business the ELECTRICAL WORLD has filled a most important part and has placed the entire industry under a lasting obligation. It may be a comparatively easy matter to raise funds today to take care of the growth and development of electrical properties, but in the earlier days when the electrical industry was struggling for recognition it was not altogether an easy matter to interest those who had capital to invest and money to loan. Capital is the most sensitive thing in the world. It flows to where there is confidence and shrinks from where there is doubt. Through the trying period of the earlier days investors found encouragement and confidence in the attitude of the ELECTRICAL WORLD as to the future demands which must arise for electrical service, and the consistent work of the editors in reporting progress and forecasting future growth had a most beneficial effect and undoubtedly aided materially in stabilizing the industry.

It might be proper to say that the function of the ELECTRICAL WORLD has been to obtain complete information of

new developments making for electrical progress and to broadcast such information promptly. By this means the industry has developed not merely from one point or in one direction but from a thousand points in scores of directions. The ELECTRICAL WORLD furnishes a complete and permanent authentic record of progress in the electrical industry. It supplies what is in effect a continuous inventory of accomplishments. It also provides a permanent record of the leaders and many other helpers whose work has made electrical history. It is a well-balanced publication, recognizing the needs of many departments within the several branches of the industry. To the ambitious every issue brings an inspiration, each page is worthy of perusal, and even the advertisements cannot be overlooked by the man who desires to have information down to the minute.

It may be truthfully said that all branches of the electrical business are greatly indebted to the ELECTRICAL WORLD for what it has done for half a century in fostering and developing the industry. Through periods of doubt and through periods of certainty, in times of stress and in times of prosperity, it has followed a steady, consistent course and has contributed a real service which cannot soon be forgotten.

S. M. KENNEDY
Vice-President
Southern California Edison Company
Los Angeles, Cal.

Voices Ideals and Duties

THE ELECTRICAL WORLD in my opinion has probably contributed as much as, if not more than, any single individual to the breadth of the industry, the progressive spirit prevailing and the public confidence in the entire electrical trade. Your recognized leadership in what is far more than a class or trade paper carries with it a great responsibility, which I am glad to note has developed with the spread of electrical knowledge. I am sure we all consider the ELECTRICAL WORLD as the consolidated voice of the highest ideals and the broadest conception of our duties and privileges as citizens and workers in this most absorbing field.

F. F. ESPENSCHIED
Consulting Engineer
Pittsburgh, Pa.

Entitled to Wonderful Credit

IT IS quite universally conceded that the ELECTRICAL WORLD has pioneered the field in the development of the electrical industry. We have always found it ready and quite willing to cooperate in any way in the advancement of the art and science of the industry, and it is surely entitled to wonderful credit for the part it has played in its development.

S. G. VINSON
Secretary and General Manager The Ideal Electric & Manufacturing Company
Mansfield, Ohio

Leadership Is Unquestioned

THE ELECTRICAL WORLD, of course, is the only journal of general circulation that covers news in the electrical field in anything like a complete manner in so far as the manufacturing and central-station interests are concerned. Its leadership is unquestioned, and I believe that the vision back of it is going to make it a more and more useful publication.

J. F. LINCOLN
Vice-President Lincoln Electric Company
Cleveland, Ohio

Bible of Electrical Achievement

THE fiftieth anniversary of the ELECTRICAL WORLD should be fittingly celebrated as the jubilee of the electrical industry from a journalistic standpoint. I have enjoyed the privilege of reading the ELECTRICAL WORLD for the last thirty-five years and believe I have read every issue during that period. The paper has combined the historical record of the development of the electrical industry with inspiration to those who have been responsible for many of the great accomplishments and with prophecies, most of which have come true.

One of my most valued possessions is a complete set of bound volumes of the ELECTRICAL WORLD from the time I commenced reading it. It is the Bible of electrical achievement.

JAMES BURKE
President Burke Electric Company
Erie, Pa.

Work Well Done Should Be Continued

IN ANY line of industry, and especially an engineering line like the electric, a technical paper, acquainting the buying public with the developments in the industry, is a necessity if that industry is to progress. As the body of technical men engaged in the industry increases, their only source of knowledge of any development is the technical journal. Properly to conduct his business, the manufacturer should have reliable statistics regarding sales, production and stocks, which can be obtained only from the journal in the field that has the confidence of the manufacturer, since information of this character is usually regarded as confidential. Statistics are needed by the financial departments, and while these can be obtained in some cases from Dun and Bradstreet, it is convenient to refer to them in the files of the journal in the industry which publishes them.

In order to fulfill these various functions, an absolutely impartial editorial policy, with a thoroughly competent editorial staff, well versed in the technical theory of the subject, is required. It seems to me that the ELECTRICAL WORLD has most creditably fulfilled all of the above functions, and its importance has increased as the industry has developed. With the present-day demands for elimination of duplication in marketing methods, it would seem essential that the work so well done in the past by your journal should be continued and extended, and I have no doubt that such will be the result.

J. C. HOBART
President Triumph Electric Company

Purveyor of Electrical News

TO MY mind the ELECTRICAL WORLD is easily the leading universal journalistic medium of the electrical industry. It has attained its place by constituting itself the purveyor of every type of electrical news. It has extended the field from which it gathers to wider limits than have ever before been reached and has said to itself, I imagine, that the only limits are those beyond which there is no more news. In volume and variety of the news it presents and in attraction and perfection of mechanical detail I consider it unsurpassed as a technical journal.

J. B. WHITEHEAD
Johns Hopkins University
Baltimore, Md.

Survival of the Fittest

IT IS scarcely possible for one of the fraternity not to be impressed with the significance of the fiftieth anniversary of the first issue of the ELECTRICAL WORLD. Fifty years is a long time in the life of man, but a very short time indeed in which to compass the tremendous accomplishments which today stand to the credit of our industry.

That the ELECTRICAL WORLD has survived and flourished during the entire life of the electrical industry speaks volumes in support of the theory of "the survival of the fittest." Your contribution to the cause of "electrifying America" can never be estimated in dollars and cents, but it can be appreciated and I trust will be rewarded.

N. A. WOLCOTT
President Packard Electric Company
Warren, Ohio

Constructive Element in Industry

YOUR valuable publication was put before the public well in advance of the real commercial birth of the electric lighting industry, which has grown to be such a tremendously important factor in the lives of our people. It is my belief that the ELECTRICAL WORLD is one of the important constructive elements in the upbuilding of this industry. The publishers and all of your associates are to be congratulated upon this the fiftieth anniversary of your birth.

FRANK W. SMITH
Vice-President
United Electric Light & Power Company
New York City

Ablest Paper in the Industry

ON THE ELECTRICAL WORLD'S fiftieth anniversary I am reminded that I have watched its splendid growth and development into the ablest paper in the electrical industry either in the United States or abroad. I do not know the exact date when my subscription started, but it is very close indeed to thirty years ago, and I have been a continual subscriber and reader ever since. The paper's progress has been a source of much pleasure to me, and I take this opportunity to congratulate you and offer my best wishes for its continued success.

R. V. BINGAY
President
Pittsburgh Transformer Company
Pittsburgh, Pa.

A Barometer and Guide

FOR thirty years I have read the ELECTRICAL WORLD consistently, and it has been a barometer and guide. I consider it a wonderful magazine—I do not think I exaggerate when I say the most wonderful magazine, it being so completely representative and having kept abreast of the times as it has during its long career. Some papers have held leadership over a period and then given place to more worthy successors, but the ELECTRICAL WORLD has held that station at least during the thirty years that I have been acquainted with it, and I wish it the greatest success to come.

L. H. CONKLIN
Consulting Engineer
Scranton, Pa.

A Reader for Forty-four Years

MY FIRST introduction to the publication now known as the ELECTRICAL WORLD was in June, 1880. At that time I had just entered the employ of the Bell Telephone Company of Pennsylvania, and Thomas D. Lockwood, chief engineer of the American Bell Telephone Company, was running a series of articles of a practical nature touching on telephone troubles. I was so benefited by the information which Mr. Lockwood gave the readers of the ELECTRICAL WORLD that I have been its constant subscriber and reader from that day to this.

Looking back through the past forty-four years, I have long since concluded that it was absolutely impossible for any man in the industry to make any marked progress unless he were a diligent reader of some publication like yours which would direct him and enlighten him on the development of the electric art.

I have never known an editorial to appear in the ELECTRICAL WORLD that was not 100 per cent in every respect. This, of course, means a lot to the subscribers of the paper, as they are positive that no "catchpenny" advertisements appear in your journal.

More than one man who has passed from lineman to general manager and chief engineer in a large company has been aided greatly in his ascent by the ELECTRICAL WORLD, which points out to the student the road to success.

WASHINGTON DEVEREUX
Chief Electrical Department
Philadelphia Fire Underwriters' Association
Philadelphia, Pa.

Kept Pace with Developments

GREAT progress has been made in the world's affairs, but so far as I am informed in no field has the march of progress equaled that of the electrical industry, and I am pleased to add that the ELECTRICAL WORLD and its staff have not only accurately recorded that progress but have themselves kept pace with the industry they represent. I have been a subscriber and reader of your paper for practically forty years and speak from first-hand knowledge.

DUDLEY FARRAND
Vice-President
Public Service Electric & Gas Company
Newark, N. J.

Filled with Inspiration and Enlightenment

I HAVE been reading the ELECTRICAL WORLD and its immediate progenitors for a full thirty-five years, and that quite regularly. Magazines have come and magazines have gone, but the ELECTRICAL WORLD has been a regular visitor to my desk and a regular consumer of my time. Scarcely an issue comes to me from which I do not tear out a page of particular interest, and frequently such pages find their way to the files of current topics that are receiving business attention.

DOUGLASS BURNETT
Manager Consolidated Gas, Electric Light & Power Company of Baltimore
Baltimore, Md.

From the Point of View of the Stoking Industry

THE wonderful development of the electrical industry owes much to the ELECTRICAL WORLD for its dissemination of news of progress. As a combustion engineer, I appreciate the attention given to my line of work. We know that electricity is largely dependent on coal, hence the stoking industry is the main foundation of your great world of electricity. From our point of view, we congratulate you on the grasp you have on all lines necessary to the still greater development due in the next fifty years. May you always be as prosperous and broad-minded as you have grown to be in the past fifty years.

R. SANFORD RILEY
President Sanford Riley Stoker Company
Worcester, Mass.

Has Led with the Leaders

A HALF CENTURY ago the electrical industry was little more than a dream. Today it is one of the world's greatest activities. Its upward course has been beset with problems—the problems of the discoverer, the promoter, the builder and the financier—and in the solution of all these the ELECTRICAL WORLD has held a foremost place. It has led with the leaders.

I congratulate the paper on its half century of service. May it continue to keep its place in the front rank of the publications that serve and stimulate the industry!

W. E. CREED
President Pacific Gas & Electric Company
San Francisco, Cal.

Inspiration to Those Engaged in the Industry

THE ELECTRICAL WORLD has done more than any other influence to stimulate the growth of the industry and guide it along correct lines. I read every issue religiously and preserve them for frequent reference. It is the best record of the past accomplishments and current news and developments of the industry and is an inspiration to those engaged in it. I wish for the ELECTRICAL WORLD an unending life in which to continue its record of increasing usefulness year by year to the industry and to society.

P. S. ARKWRIGHT
President
Georgia Railway & Power Company
Atlanta, Ga.

Sound Economic Views

PERMIT me to congratulate the ELECTRICAL WORLD on its fiftieth anniversary and to express to you, as one identified with the electrical industry for a number of years, my appreciation of the valuable work which your publication has done for it. The technical articles are of the greatest benefit to the technical staff of all utility companies, and through them to society as a whole—but you are to be congratulated no less upon the sound economic views which find expression in your editorial columns.

THOMAS W. MARTIN
President Alabama Power Company
Birmingham, Ala.

Great Value of Statistics

AN EVENT such as the celebration of the fiftieth anniversary of the ELECTRICAL WORLD is more than a milestone in American electrical history. Half a century of continuous service to a branch of engineering that has been the means to such remarkable growth in American resources, and indeed in the development of American life, is no small achievement. The ELECTRICAL WORLD has done so many things that a book might be written of them and still do insufficient justice. One contribu-

tion which has much significance surely to the central-station industry is found in those yearly records of central-station output and progress which have come to be regarded as in themselves milestones. These records are more than statistical material; they are an index to our national growth, because the power industry of today reaches into almost every phase of American life and activity.

CHARLES PENROSE
Assistant General Manager
Day & Zimmermann, Inc.
Philadelphia, Pa.

Broadcasts Latest Developments

THE ELECTRICAL WORLD has indeed contributed very greatly to the electrical industry by broadcasting the latest developments in this rapidly changing field. I can only congratulate you upon your long years of usefulness and success so richly deserved.

A. H. ARMSTRONG
Chairman Electrification Committee
Schenectady, N. Y.

Records the History of the Art

FOR forty out of the fifty years I have been a regular reader of the ELECTRICAL WORLD, and therefore I am fully cognizant of the effective way in which the paper has recorded the history of the art from week to week and how useful and stimulating this record and your editorial comments have been to your readers; but the very fact that you have performed this service so creditably makes it well-nigh impossible to pick out any one function which you have performed exceptionally well.

WALTER S. MOODY
General Electric Company
Pittsfield, Mass.

An Inspiration to Electrical Industry

IT STRIKES me as particularly fitting at this time, which in my judgment marks the beginning of a new era in electrical development, that the ELECTRICAL WORLD, established in 1874 at the very threshold of the electrical industry, should commemorate its fiftieth anniversary. No more complete, no more detailed history of electrical development could be obtained than from its files. Nothing in my judgment has been a greater factor in this development than has the ELECTRICAL WORLD, furnishing as it has not only a medium for the exchange of the experiences and ideas of those interested in electrical development, but through its pages always leading the way and supplying inspiration to the workers in the electrical field.

J. F. OWENS
Vice-President and General Manager
Oklahoma Gas & Electric Company
Oklahoma City, Okla.

Keeps Pace with Advanced Thought

EVER since my connection with the electric light and power industry, covering a period of approximately twenty-eight years, I have been a reader of the ELECTRICAL WORLD. Looking back over that period, it seems to me that the history of the paper and of the industry have been along parallel lines, namely, constantly increasing growth and development. To a man in my position, just starting in the business with no technical knowledge, the ELECTRICAL WORLD was extremely valuable in keeping me advised as to the thoughts and practices of the best minds in the industry. As my own field of activities has broadened, I have always found the ELECTRICAL WORLD keeping pace with advanced thought in all phases of electric light and power.

In the treatment in its editorial columns of the broad questions of policy and management, in the various and excellent articles dealing with intricate details of technical problems, and in the columns devoted to the commercial side of the business, the ELECTRICAL WORLD has always shown a broad and sympathetic understanding of the industry and its needs. Its service record for the half century is one of which it may well be proud.

H. T. SANDS
Vice-President C. H. Tenney & Company
Boston, Mass.

Emphasizes Educational Value

IN MY own experience with the ELECTRICAL WORLD, and especially when I was a young engineer just out of college, it was the educational value of the paper which made the most distinct impression upon me and which is a very distinct recollection to this day. I was so much impressed with the value of the ELECTRICAL WORLD that for many years I had my copies bound so that I might keep them in my own library for ready reference.

F. S. HUNTING
President Robbins & Myers Company
Springfield, Ohio

Interesting, Enjoyable and Instructive

I BELIEVE that the ELECTRICAL WORLD is an excellent example of the attitude that a paper should take toward the industry it serves. During the many years that I have read the paper it has always seemed to me that it has expanded and improved its service at about the same rate as the general growth of the industry. In other words, it has kept up with the general progress of the industry.

The fact that the ELECTRICAL WORLD covers the various operating and business features of the industry, as well as the theoretical and ordinary engineering problems, makes it, in my opinion, more interesting and of more general value to its readers. As a result, I believe that many of your readers find its pages not only instructive but really interesting and enjoyable.

N. J. CONRAD
General Manager
Schweitzer & Conrad, Inc.
Chicago, Ill.

Constructive and Forceful Policy

FOR many years I have been a regular reader of the ELECTRICAL WORLD, and I do not permit any issue to leave my desk for our files until I have had opportunity to examine it. Your publication has been of distinct value to our industry both in the gathering and printing of very full and reliable information from week to week and in the constructive and forceful editorial policy which has always characterized it.

W. W. FREEMAN
President Union Gas & Electric Company
Cincinnati, Ohio

Vision, Courage and Progress

THE ELECTRICAL WORLD reflects the character of the electric light and power industry. It has done more to bring the industry into close union than any other electrical periodical. Its articles are always inspiring and stimulating to persons connected with the industry. The vision, courage and progress of the ELECTRICAL WORLD have been a most important factor in the development of the electric light and power industry to its present high standard.

J. H. SHEARER
Vice-President
Penn Central Light & Power Company
Altoona, Pa.

Potent Factor in Development

ALLOW me to express to the ELECTRICAL WORLD my hearty congratulations on this celebration of its fiftieth anniversary. To attempt to recall and select any single achievement during the many years which I have been a reader of the ELECTRICAL WORLD is practically impossible. It has continuously and effectively reported the news of the industry, and its editorial policy has been a potent factor in the wonderful development of the electric light and power business through the country. The many problems which the industry has had to face have been discussed with marked ability and with a vision of future possibilities which have been an inspiration to those in direct charge of the operations of the electric companies.

C. H. B. CHAPIN
Secretary
Empire State Gas and Electric Association
New York City, N.Y.

Has Helped Bring Industry Forward

THE ELECTRICAL WORLD is one of the major forces which have assisted in bringing the electrical industry to its present state. This is by reason, of course, of the fact that it has been one of the greatest, if not the greatest, means of keeping engineers in all localities well posted on the work and accomplishments of engineers in all other localities.

The ELECTRICAL WORLD has supplied me with desired information from the time I started in central-station work as a repairman and meterman, through a number of stages covering a great many phases of work, to the work which I am now doing. I know also that the ELECTRICAL WORLD is still ahead of me and will still have information of interest and value to me as my work may change in scope or kind.

E. P. PECK
General Superintendent
Electric Department
Utica Gas & Electric Company
Utica, N. Y.

Head and Shoulders Above Competitors

I PERSONALLY have been in the electrical field with the Okonite Company for forty of these fifty years, and can truly say that the ELECTRICAL WORLD has always, in my mind, stood forth head and shoulders above its so-called competitors, both as a technical authority and also as a most interesting and readable magazine. It must be most difficult to treat of highly technical matters in such a way that while the facts are truly accurate, the method of expressing these facts is such as to make the articles interesting reading to the semi-technical-layman. This you have always succeeded in doing.

H. D. CHEEVER
President Okonite Company
New York City, N. Y.

Collects and Interprets Knowledge

NO greater progress has been made in the last fifty years than in the field of electrical engineering. The rapidity of this progress would have been utterly impossible without the great work of collection, interpretation, transportation and distribution of knowledge and experience by the electrical press. In this the ELECTRICAL WORLD has played an enviable part. Its work must be different from but still supplemental to that of the more specialized journals of the technical societies. Starting fifty years ago as a magazine devoted to one-volt transmission of intelligence over a telegraph wire, it has kept pace with the electrical progress of today, when thousands of kilowatts are transmitted hundreds of miles over a single wire, when intelligence is transmitted without wires at all, and when all matter, in fact, is thought to be made up of chunks of electricity.

The field of electrical engineering has become so large that, although specialization is necessary, contact must be kept between the various specialized groups. As an example, the work of the designing engineer lies between mechanics on the one hand and mathematics and physics on the other. Much of the mathematics and physics appears in philosophical magazines which are seldom read by engineers. Correlation and distribution are important. Electrical engineering owes a great debt to and can well be proud of the journal that has performed this service and performed it well for half a century.

F. W. PEEK, JR.
Consulting Engineer
General Electric Company
Pittsfield, Mass.

A Supporting Pillar in the Electrical Structure

TO SERVE efficiently for these fifty years of geometrically increasing electrical applications as a dependable, unbiased record of small as well as great discoveries, developments, practical applications and commercial advancements, and to discuss the theory and practice, existing and proposed, in a great diversity and multitude of visions of this world electrical, surely has been no puny task. The answer to how well this has been accomplished is found in the semi-centennial issue of the ELECTRICAL WORLD, and those that have each week for many years preceded it. In the universality of its treatment of science and practice, whether within or without its belief and opinion, it has been Bible, Talmud, Koran and Book of Confucius to the electrical world rather than a mere industry publication. *It* is the electrical world.

Other arts and industries boast of excellent mediums serving as recorders and commentaries; but the electrical industry probably stands alone in the number, size and multi-directional character of its ramifications. The ELECTRICAL WORLD, growing with the industry, has expandingly embraced all of the art from battery to turbo-generator and from Ohm's law to the most highly intricate mathematical exposition of new phenomena. As instructor and guide to expert as well as novice, and in always maintaining a policy of "justice to all, malice toward none," in presenting electrical fancies as well as facts, it has firmly rooted itself as a vitally essential pillar supporting this great industrial structure. The industry may rest assured that the principles and practices on which it is founded will be exhaustively and earnestly expounded and that the record of its present and future will be fair and accurate, so long as we have our ELECTRICAL WORLD.

JOSEPH SACHS
Chief Engineer Johns-Pratt Company
Hartford, Conn.

Measured Reporting a Feature

THE most striking feature of the electrical industry as a whole is its use of measurements and its development of accurate measurements. Many of the measurements in other industries have been made possible only by the electrical developments, and many of them —as, for instance, the more accurate measurement of steam—have been forced on the other industries by electrical needs.

The ELECTRICAL WORLD, as the leading paper of the electrical industry, has, of course, been the chief means of bringing the electrical industry before the public and the other industries, and by its accurate—that is, measured—reporting it has been the chief means of developing the electrical industry as a whole and its most striking feature, the use of measurements. R. S. HALE
Superintendent
Special Research Department
Edison Electric Illuminating Company of Boston

Helped to Develop Standard Equipment

THE approaching fiftieth anniversary of the ELECTRICAL WORLD puts me in a somewhat retrospective mood—a luxury seldom indulged in by busy manufacturers. Recalling the early difficulties encountered in the introduction of standardized substations for greater economy and safety in the distribution of electrical energy, I now fully appreciate that the message could not have been so well defined nor the idea put across had it not received the hearty co-operation and powerful aid of the ELECTRICAL WORLD.

Your editors did not always agree with us, but were ready to listen and give every man an opportunity to voice his views. The facts carefully gathered from various sources by your editorial department to bring out the pro and con of outdoor construction kept the subject alive and accelerated more than anything else the rapid development of standardized equipment by the manufacturing branch of the industry.

In the indoor switching and busbar equipment field I have also had an opportunity to observe the constructive influence of your publication. Many years ago Delta-Star published what we believe to be the first curve showing forces between conductors during short circuit and at that time attempted to emphasize the importance of the mechanical features of busbar layouts. Little attention was given it until the ELECTRICAL WORLD took up the question, with the result that today mechanical considerations overshadow the electrical in busbar and conductor layouts as well as in the selection and spacing of insulators for disconnecting switches.

Many other instances come to mind where your good work has benefited the

entire electrical industry. The story would be too long for a fiftieth anniversary letter, but the sum total leaves a predominating impression that the ELECTRICAL WORLD has always been a real progressive—although one hesitates to use a word so much abused by our political friends.

H. W. YOUNG
President
Delta-Star Electric Company
Chicago

Necessary to Successful Development of the Industry

PERHAPS the greatest service the ELECTRICAL WORLD has rendered to the world during the last fifty years is its "unknown service." Millions of seeds that have brought forth harvests of incalculable value have forgotten their sower. For example, one evening in 1890 I carelessly opened a copy of the ELECTRICAL WORLD and chanced to read an item not over an inch long that quoted a professor of McGill University to the effect that only three-tenths of 1 per cent of the energy of the coal pile was actually transformed into electric light.

Very probably this information was not new to me, but on this occasion it struck me like a blow, and a blow of such intensity that its effects have not died away even to this hour. A careful perusal of the history of gaseous conduction would prove how important this simple example of the "unknown service" of the ELECTRICAL WORLD has been.

Doubtless very few of your present-day readers can give personal testimony covering the entire fifty years, yet many of us who first became acquainted with the paper during our college days remember most of the present-day industrial electrical giants as very small infants. And during this entire period the contents of very few issues of the "leading electrical journal" failed to pass under our eyes.

Of course, many of us include in the service of the ELECTRICAL WORLD that very considerable contribution of the *Electrical Engineer* and its splendid editors, who by their optimistic and sympathetic encouragement aided many a flickering spark to burst into useful flame, but both of whom have now passed to their reward.

The weekly service is now greater than ever, but how it has changed! Then the publication of a moonlight table for the struggling central stations was a scoop.

I fear we sometimes forget that the publication of a paper like the ELECTRICAL WORLD, with its editorials, articles, digests and advertisements, is an absolute necessity to the successful development of the industry, as a whole, which it represents. And it is exhilarating to think of what the ELECTRICAL WORLD is going to record in the next fifty years.

D. McFARLAN MOORE
Illuminating Engineer
Harrison, N. J.

Far-Seeing Electrical Policy

A PAPER which has weathered the ups and downs of the industry which it serves for fifty years must of necessity possess merits. I have personally appreciated the merits of the ELECTRICAL WORLD for half of this period and wish to congratulate it upon its fiftieth anniversary. I also wish to congratulate its management upon the selection of men with far-seeing editorial policies. It is doubtful whether any other industry has co-operated so consistently to build up the trade of its various units, and the leadership in this has undoubtedly come through your paper.

The searching out of new ways in which your organization could be of service to the industry is, to my mind, the outstanding contribution, and it is hard to conceive of a more complete service than is being rendered by your combined departments, all working toward the expansion of our essential industry.

W. F. HUBLEY
President and General Manager
American Transformer Company
Newark, N. J.

Leader for Half a Century

TO HAVE been the recognized leading electrical paper of America—and, in fact, it is not too much to say the leading electrical paper of the whole world—for half a century is indeed a most notable record. Many able men have edited your journal since the early days of the *Operator*, and while I would hesitate to particularize, were I asked who among them all has impressed me the most favorably by reason of his technical knowledge, his facile editorial pen, his thoroughness and his efforts to prevent your paper from lowering its tone to that of a purely trade publication, I would say the late Lieut. William D. Weaver.

W. J. HAMMER
Consulting Engineer
New York, N. Y.

A Beacon Light to Progress

DURING the half century covering the life of the ELECTRICAL WORLD the electrical industry has grown from a minor position, dependent upon a few crude and experimental devices, to its present huge proportions. Over all this period I have found that the ELECTRICAL WORLD has faithfully recorded current progress along electrical lines. Its pages have reflected the spirit of the industry from the earliest period when our problems and progress appeared to be chiefly technical down to the present period when technical progress represents the advance guard of a tremendous commercial development.

To me an outstanding achievement of the ELECTRICAL WORLD has been the guidance and inspiration which it has offered to young men just entering the field. Technical information along many varied lines has been available in bewildering abundance in books and in magazines specializing along those lines. The ELECTRICAL WORLD, however, by recording and discussing the more important events of the whole electrical field, has given the young man an understanding of the various phases of the electrical industry and their relations with each other which he could not otherwise secure. Its record of current developments has been to him a beacon light pointing to paths along which progress is being made. Its pages have undoubtedly guided many a young man to a wiser choice of the line along which he would specialize and have given him a broader and more intelligent understanding of his work.

CHARLES W. HOLTZER
President Holtzer-Cabot Electric Company
Boston, Mass.

Teaches Lesson of Constructive Co-operation

DURING its life of fifty years the ELECTRICAL WORLD has watched the whole growth of the electrical industry as we know it today. It has witnessed the entire development of equipment for the generation, transmission and use of electrical energy. No telephone, either wired or wireless, had any part in its original make-up, and no electric lights assisted its toiling editors in their early efforts. Since that time some six billion dollars has been invested in the electric light and power industry, and it is estimated that this amount will be doubled in the next ten years.

Public utility executives have been faced with the problem of economically obtaining this huge sum, equivalent to one-third the total debt of the United States, of using it wisely so that interest and dividends may be earned, thereby securing the right to ask the continued support of the investing public, and at the same time to see that their companies comply with the rulings of, and sell their services at rates made by, the regulatory bodies of the state.

The task has required the earnest co-operation of the financier, the designer, the contractor and the operator, and always the ELECTRICAL WORLD has been at hand to aid in co-ordinating their efforts so that the desired result might be secured. It has recorded business, manufacturing and market conditions, reported on public and financial policies and reviewed rate theories and decisions; it has furnished the designer with descriptions of the latest developments in equipment and has portrayed for him not only the up-to-date superpower station but also the inconspicuous installations upon which, after all, the industry is built. It has tabulated material prices and construction costs and has outlined useful methods for the construction man; it has furnished to the busy manager information concerning conditions on other properties and has supplied him with information for his studies of public relations and merchandising methods. For the operator it

has presented a record of station economies and operating practice which, properly utilized, has enabled him to bear down heavily on the "operating ratio."

In addition, it has maintained an able staff always at the service of our national associations and has constantly endeavored to forecast the trend of development throughout the industry so that some progress might be made toward the solution of future problems.

It is evident, therefore, that it has had no small part in bringing public utilities into favor with investors, and we can look forward cheerfully to the prospect which seems open to us and wish for the ELECTRICAL WORLD a continuation of its well-deserved growth and influence.

EDWIN S. WEBSTER
President Stone & Webster, Inc.
Boston, Mass.

A National Paper

ALTHOUGH published in New York City, the ELECTRICAL WORLD has always been a national, not a sectional paper. The Pacific Coast has been as truly its territory as the North Atlantic States. It has discussed Western problems with the same familiarity as those in the states where conditions are so widely different. Separated from the center of population by distance and geographical barriers, the electrical men of Washington, Oregon and California and the sparsely settled neighboring states have needed a great industry organ even more than have their confreres elsewhere, and the ELECTRICAL WORLD has filled the need.

To the National Electric Light Association the paper has always filled in high degree the role of "guide, philosopher and friend." Like the association, it is as broad as America. Like electricity, it is an agency which unifies and unites.

FRANKLIN T. GRIFFITH
President
National Electric Light Association
Portland, Ore

Calls Attention to New Development

SEVERAL months ago an issue of the ELECTRICAL WORLD carried on the front cover an illustration of a 4,000-hp. Diesel generating unit, calling to the attention of the electrical industry the attractive possibilities of large Diesel engines. The Panama Canal has since received bids from nine American manufacturers on three 3,750-hp. Diesels and a 7,500-kw. Diesel auxiliary station and contemplates following this initial installation with much larger units. Professor Adolph Nagel of Dresden told me yesterday that the Hamburg Electric Works had placed an order for a 15,000-hp. Diesel generating unit to carry peak loads in its steam-turbine station, permitting the turbines to be operated at more advantageous load factors.

The ELECTRICAL WORLD in this instance has again shown the way, conservatively and yet generously, to a comparatively new prime mover, thus advancing that progress in the electrical industry which it has furthered so strikingly during the past fifty years.

EDWARD B. POLLISTER
General Manager
Busch-Sulzer Bros.-Diesel Engine Co.
St. Louis, Mo.

Its Opinions Accepted as an Ultimatum

IN THE early days, when not only I but every other ambitious novice used to wait impatiently for the weekly appearance of the ELECTRICAL WORLD and read it from cover to cover, including its advertisements, for the food our minds demanded, what the ELECTRICAL WORLD thought and said about anything was pretty nearly an ultimatum and was accepted as such. As the early Church was historian, legislator, physician and philosopher to early man, so were the function and influence of the ELECTRICAL WORLD in the day when it was our chief light. It was managed with high motives and was much more than commercial. The art owes it an inextinguishable debt.

GANO DUNN
President
J. G. White Engineering Corporation
New York City

A Fair and Impartial Editorial Policy

I HAVE always had a very high regard for the ELECTRICAL WORLD, and particularly for its editorial opinions. I do not know who has written them or who has been responsible for the policy; but it seems to me that they have always pointed toward the improvement of the industry as a whole and have never been actuated by the attitude which any of the advertisers might dictate. I think these editorials have always been fair and impartial and have done much to counteract short-sighted policies which some individuals or industries have at times attempted to force on the public. While the ELECTRICAL WORLD has given due attention to engineering features, I think it has always had in mind the true economics of the industry and has kept a very nice balance between the commercial and the engineering features.

W. H. BLOOD, JR.
Stone & Webster, Inc.
Boston, Mass.

An Asset to the Industry

THE ELECTRICAL WORLD is one of the great assets of the electrical industry. Not only does it render surpassing service in familiarizing executives, operators and others with what is going on technically, commercially and financially; but its interpretation of events, its guidance on matters of policy, and, above all, the hearty co-operation and support it has always given the industry have won for it recognition as the foremost exponent of electrical development in the world. Its staff is made up of men who have made constructive contributions, individually and collectively, to the advancement of the industry and have also rendered magnificent service in bringing a knowledge of the industry's accomplishments to the general public.

M. H. AYLESWORTH
Managing Director
National Electric Light Association
New York City

Valuable and Stabilizing Influence

IT IS my business to keep abreast of the electrical business, and any man who has read the ELECTRICAL WORLD consistently for years cannot fail to have a good working knowledge of the electrical industry. Faithfully it has recorded step by step every achievement of the science; it has chronicled every important development and has always given wise and conservative counsel which I believe has had a most valuable and stabilizing influence on the electrical business of this continent.

The influence of the ELECTRICAL WORLD is by no means confined to its circulation among those of us who are connected with the electrical industry, but is multiplied innumerably by the "rewrites" of its news and the revoicing of its opinions by the press of America, thus expanding its work to national, perhaps world-wide, scope.

R. H. BALLARD
Vice-President and General Manager
Southern California Edison Company
Los Angeles, Cal.

Encourages International Electrical Standardization

IN 1904 Colonel Crompton read a paper at the St. Louis Exposition on electrical standardization. I was then young in this work, but was closely connected with Colonel Crompton and on his return to England the first steps which resulted in the foundation of the International Electrotechnical Commission were taken. As a result of the resolution passed by the government delegates at St. Louis in 1906 the I. E. C. came into being, and I recognized at once how invaluable it would be to have constantly before one the progress of the great electrical industry of America. I looked around and naturally wrote to the ELECTRICAL WORLD.

Since that time I have received my copy of the ELECTRICAL WORLD and have always found it of very real assistance. It has given one a picture of the progress of the electrical industry not

only in America but indeed in many different parts of the world, and each time I have been in America the ELECTRICAL WORLD has helped me by giving me as it were a bird's-eye view of what I expected and what as a matter of fact I saw.

The ELECTRICAL WORLD is to be seen in many different countries, and I feel certain that those who have received it have, like myself, felt its value and influence. Standardization, or simplification, as it is much better to call it, is being carried on in these countries. The electrical industry because its basic units are the same all over the world is able to make more progress in international standardization than perhaps are the other industries. The work of standardization calls for a good deal of optimism as well as idealism of a practical nature, but as all standardization has economy as its basis, both the user and the manufacturer have a deep interest in its success.

The ELECTRICAL WORLD can in the future, as it has done in the past, play a great part in disseminating an appreciation of the value of unification both national and international by bringing technicians more and more together and so helping to promote better understanding among the scientific thinkers of the world. Politicians come and go, but the engineering industries of the various countries are the most stable portion of society and have a great future before them.

C. LE MAISTRE
Secretary
International Electrotechnical Commission
London, England

Foreign Appreciation of American Practice

I HAVE been a regular foreign reader of the ELECTRICAL WORLD for about thirty years. I am proud to have been also a contributor to it of some electrical papers. Its contents come from all over the world and go around the globe. I highly appreciate your journal for the thorough information I have always got from it about all practical and scientific questions relating to electricity in the United States. During my two visits to the States my American friends were usually astonished at my intimate knowledge on nearly all important electrical plants in America, which knowledge I owe nearly exclusively to the ELECTRICAL WORLD. I am sure that all foreign electrical engineers who know your great country heartily welcome each new number of the ELECTRICAL WORLD as the connecting link with their American friends.

The influence and importance of electricity are still mightily growing every year, and so the paper will find many new friends all over the world. A hearty "*Vivat, crescat, floreat*" to the ELECTRICAL WORLD!

PROF. DR. F. NIETHAMMER
Institute of Electrotechnics
Prague, Czechoslovakia

An Encyclopedia of Electrical Engineering

AS ONE of the earliest English subscribers and beneficiaries of the ELECTRICAL WORLD, I am delighted to testify to the benefit I have continuously derived from its weekly perusal and to the pleasure I take in calling the attention of my fellow engineers on this side to its unique qualities as an encyclopedia of modern electrical engineering.

I consider that your very generous allotment of space to both the engineering and commercial subjects puts the ELECTRICAL WORLD in the forefront of all the weekly publications I am acquainted with. To me one of the most appreciated features of the paper is the very unusual amount of space given to useful graphs and the very fine illustrations of engineering works in progress in America.

ARTHUR WRIGHT
Consulting Engineer
Kensington, London, England

Admires Its Digest of Electrical Literature

IT IS a pleasure to express my appreciation of the many-sided service which this magazine provides for the electrical industry. To mention one item, its advocacy of interconnection of electrical systems has done much to influence development in this particular along correct lines.

One department has always appealed to me personally, namely, the Digest of Electrical Literature. The reviews of articles are prepared with sufficient care and are long enough to give an idea of the essential points of an article and to enable one to decide whether it is desirable to send for the complete article. Many articles describing new apparatus or new solutions of problems have first come to my attention through this department, and I hope it will long continue in its present form.

H. B. DWIGHT
Canadian Westinghouse Company
Hamilton, Ont.

An Exponent of International Intercourse

IT IS not necessary to emphasize in a general way the enormous utility of the technical press and its far-reaching influence on the development of technics; but in all matters the results are in relation to the thoroughness and scope of the action employed, and it must be said to the honor of the founders and editors of the *Operator* first and subsequently of the ELECTRICAL WORLD that they have given such a character to their journal as to make of it a unique model. Moreover, the effort of the majority of editors to keep their journals up to the standard of the ELECTRICAL WORLD has improved the whole electrical press all over the world.

As president of the International Electrotechnical Commission, I may add that I must recognize the sincere support that the ELECTRICAL WORLD has always given spontaneously to its work. Such support has been given not only by adequate reports of the actions of the commission, but also indirectly. One of the characteristics of the ELECTRICAL WORLD has always been its aim to be a world journal; in fact, all news has received the same consideration regardless of the country of origin, and this sincere international attitude has been of the highest value in creating the mental habit of international intercourse.

G. SEMENZA
President of the International Electrotechnical Commission
Milan, Italy

Great Factor in Progress Toward Universal Service

THE ELECTRICAL WORLD has for several years followed and recorded the achievements particularly of our operating and distributing companies. It has been of great service to the industry in pointing out the fact that the use of electricity is becoming more universal and that the industry must equip itself to take care of this growing demand.

Quite aside from recording the great achievements in specialized lines and the work done by brilliant scientists, engineers and others in the industry, the ELECTRICAL WORLD has been a great factor in the progress toward the universal service which now seems inevitable.

JULIAN C. SMITH
General Manager
Shawinigan Water & Power Company
Montreal, Que.

Gives World-Wide Information

I READ the ELECTRICAL WORLD with great interest, as it always is up to date regarding the latest news in the electrical field, with descriptions and pictures of great new water-power stations and power-transmitting lines, besides publishing technical and economical results of the use of electricity in the home, industry, agriculture, etc.

The ELECTRICAL WORLD has a specially good system of information, which enables it quickly to follow the progress of the electrical art not only in the United States, but also in the other countries of the world. It therefore gives the reader the latest and best news regarding the progress of electrical undertakings in the different countries besides publishing the results which have been obtained in a technical, economical and administrative way to the experts who are working on the solution of these questions in the various nations of the world.

THOS. NORBERG SCHULZ
Electrical Director of Water Power
Christiania, Norway

In Two Sections—Section Two

Electrical World

McGraw-Hill Company, Inc.

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NEWS OF THE INDUSTRY

Franklin Institute a Mecca

Scientists and Engineers from America and Europe Gather at Philadelphia for Centenary

PHILADELPHIA on Wednesday of this week saw the opening of the three-day centenary celebration of the founding of the Franklin Institute, which has rendered such great service to the electrical art as well as to every other branch of science and technology. In connection with the celebration, inauguration exercises were held for the Bartol Research Foundation, which owes its existence to a bequest of $1,208,468 made to the Franklin Institute in 1921 by Henry W. Bartol. Elihu Thomson was chairman of the honorary committee of the celebration, of which Thomas A. Edison, Charles A. Coffin, Samuel Insull, Joseph B. McCall, Nicholas F. Brady and other men prominent in utility and industrial circles were members. William C. L. Eglin, vice-president of the Philadelphia Electric Company, is president of the Franklin Institute. Many distinguished scientists from this country and Europe were present at the celebration, including Sir Ernest Rutherford, Cavendish professor of experimental physics at Cambridge; Sir William H. Bragg, Quain professor of physics at the University of London; William H. Patchell, consulting mechanical and electrical engineer of London; Profs. F. G. Donnan and J. S. E. Townsend of England, and Prof. Pieter Zeeman of Amsterdam.

The exercises on the first day included a symposium on the development of aëronautics and electrical communication, and the speakers included Major General Mason M. Patrick of the United States Army air service, Prof. Joseph S. Ames of Johns Hopkins, whose subject was "Recent Developments in Aëronautics"; Major General George O. Squier, who spoke on "Electrical Communications for Military Purposes," and John J. Carty, who had charge of the American communications in France during the world war and who spoke on "Progress in Telephony." President Eglin and Elihu Thomson also made addresses.

At the University of Pennsylvania Dexter S. Kimball, dean of the School of Engineering of Cornell University, spoke on "The Progress and Promise of Engineering." He demonstrated in his address the importance that engineering science plays in our present civilization, advocating less politics and more rational thinking in the conducting of public institutions.

Prof. W. Lash Miller of the University of Toronto read a highly technical paper on the "Concentration and Polarization of the Cathode During Electrolysis of a Solution of Copper Salts."

Dr. W. D. Coolidge, assistant director of the research laboratory of the General Electric Company at Schenectady, N. Y., talked on recent X-ray development and told of a new machine which would have numerous commercial and domestic applications, permitting, for instance, a view of concealed pipes or the ascertainment of the right spot in a wall to drive a nail. Dr. Coolidge also gave a technical interpretation of the physical principles involved in the hot-cathode type of X-ray and of the high-power tube which functions at 250,000 volts.

Duquesne Light Company Plans New Station

A site on the Ohio River just below the borough of Shippingport, Beaver County, Pa., has been acquired by the Duquesne Light Company of Pittsburgh for a new power station. This station, when in service, will be the third large station on the company's 66,000-volt ring that surrounds industrial Pittsburgh—the Brunot Island station, in the heart of the downtown district, and the Colfax station, situated approximately 16 miles northeast of the center of the city, being the others.

These three large stations will be at triangular points on the 66,000-volt ring. The new station will be modeled somewhat after Colfax, and its ultimate capacity will be in the neighborhood of 300,000 kw. The ultimate cost cannot be estimated at this time, but J. M. Graves, general manager of the company, says that it will be in the neighborhood of $30,000,000. The project is only in its first stages, however, and no actual construction work will be started this year. The company has purchased approximately 765 acres of surface land and nearly 2,000 acres of coal land in and about Shippingport. The first development will be started in 1925.

Arizona and the Colorado

Governor Still Against Seven-State Compact—Opponent Favors It with Reservations

RENOMINATED by the Democratic party for a fifth term as Governor of Arizona, George W. P. Hunt declares himself still an opponent of the Colorado River compact, which met the approval of the federal authorities and the other six states of the Colorado basin—Wyoming, Nevada, Utah, Colorado, California and New Mexico. Governor Hunt stands on state rights, declaring that if California or Colorado wants water or power from the Colorado River she must buy it from Arizona, that Arizona needs the water for irrigating two million acres and that it by right belongs to her alone.

Governor Hunt's Republican opponent, Dwight B. Heard of Phoenix, a prominent business man with a long record of public service, is for the compact with reservations insuring Arizona possession of the water necessary to irrigate and develop all lands reclaimable at reasonable cost now or in the future and with provisions for the payment into the treasury of the State of Arizona of the proceeds of a production tax on hydro-electric power generated at sites wholly or partly within the state by public or private agencies and delivered and used outside of the state. The Republican candidate further avows his advocacy of a vigorous effort to obtain from the federal government a direct appropriation for flood control on the river at a site to be selected by United States engineers. Mr. Heard favors also the protection of Arizona's right to the use of Colorado River water against any further appropriation of this water for lands in Mexico. He declares, too, for a state tax on hydro-electric works developed on the Colorado River by private interests on federal as well as on privately owned lands.

Heard has also a plan for a co-operative construction project on the Colorado in which all interests would unite with rates and methods of service under public control. Observers in Arizona report that while the state is strongly Democratic Heard has a fair chance of election since many people are tired of Governor Hunt's continuous rule.

Ambitious Program at Birmingham

Southeastern Section, N. E. L. A., Alive to the Great Industrial and Electrical Development in Its Territory, Holds Noteworthy Convention

THE twelfth annual convention of the Southeastern Division of the National Electric Light Association opened in Birmingham on Monday, September 15, with the most ambitious program ever undertaken by this division. Following an address of welcome by R. I. Ingalls, president of the Birmingham Chamber of Commerce, T. W. Martin, president of the Southeastern Division and also of the Alabama Power Company, reviewed the work of the past year and called attention to certain important factors that must receive attention in the near future. In discussing the wonderful development industrially of the Southeast Mr. Martin asserted that industrial development in the past ten years for the United States at large had grown 148 per cent, but in the Southeast this increase was 213 per cent. This was possible only because the public utilities furnished the necessary power. Mr. Martin estimated that within the next ten years the public utilities of the Southeast must have available a generating capacity of 3,000,000 additional horsepower, with an annual product of 8,000,000,000 kw.-hr. He spoke of the part that interconnection in the Southeast played in meeting the demands of industry and said that it was of importance that the public be made to understand that interconnection did not mean a common control of the companies.

Martin J. Insull, president of the Middle West Utilities Company, spoke at length on the importance of good public relations. He emphasized the fact that as a preliminary to such relations there must of necessity be good relations within the company and that the employees of all utilities must be well informed of the aims and policies of the utilities before the public can gain an appreciation of this subject.

I. S. Field, secretary of the *Manufacturers' Record*, gave an address on the necessity to advertise the resources of the Southeastern territory widely and thus to establish the confidence of the financial interests in the soundness and future of the section.

Public Ownership Fallacy

The fallacy of public ownership of utilities came in for attention in the speech of Franklin T. Griffith, president of the parent body. No other industry in the United States, he thought, was gaining confidence so rapidly as the electrical industry, and he ascribed this increased confidence to the fact that small investors were being drawn into the industry through customer ownership.

F. A. Wilson-Lawrenson, publisher of the Atlanta *Georgian*, spoke on cooperation between the public utilities and the press. Mr. Lawrenson held that public utilities had just as much right to take part in politics as had individuals and that the same factors control the interest of the public utilities and the individual in political affairs.

Other speakers of note before the general session were A. K. Baylor of the General Electric Company, New York City; M. H. Aylesworth, managing director of the N. E. L. A.; F. W. Hoover, Consumers Power Company, Jackson, Mich., and Dr. E. A. White, director of the Committee on the Relation of Electricity to Agriculture.

The better-home lighting campaign came in for a generous share of attention. Rex Cole, president of the Miller Lamp Company, outlined the national aspects of the contest before the general session, and C. A. Collier, regional director for the Southeast, talked on the same subject before the commercial session. The Southeastern Section is, they said, excellently organized in this activity, over 80 per cent of the larger communities being engaged in preliminaries of the essay-writing contest.

The women's public information committee work and its importance to the industry were especially stressed. Miss Sophia Malicki of the Middle West Utilities Company spoke most interestingly on the national activities of this committee, and Miss Ruth Morris, chairman of the Southeastern women's committee, brought out the fact that the committee work in this division had been participated in by more than 75 per cent of the women employees of member companies.

Parallel sessions of the Technical, Public Relations, Commercial and Accounting Sections were held on Monday, Tuesday and Thursday afternoons. Wednesday was devoted to a trip to inspect the hydro-electric developments of the Alabama Power Company at Lock 12 and Mitchell Dam. Improved lighting conditions and sales work in connection therewith filled an important part in the Commercial Section program, as did also the application of motor drive to the ice industry and coal and iron industries.

Rocky Mountain Division in Session

Women Occupy Conspicuous Place, with Nearly One-third of Attendance, One Chairman and Two Speakers—Casper (Wyo.) Mayor Gives Own Viewpoint

A WELL-ROUNDED, constructive program, with a dominant public relations strain and evincing a marked interest in the national home-lighting activity, was carried through at the annual joint convention of the Rocky Mountain Geographic Division, National Electric Light Association, and the Colorado Public Service Association at Glenwood Springs, Col., on Monday to Wednesday, September 15-17. With a registration of nearly two hundred all records for attendance were broken. More than sixty women were present, and one session was devoted to women's public information work under the direction of Miss Inez Thompson, division chairman. Mrs. Florence A. Tate, secretary Kentucky Hydro-Electric Company, represented Miss R. E. McKee, national director of women's work, on the main program and at the special session.

Although far removed from association activities, the paper by Miss Sarah M. Sheridan, vice-president in charge of sales, Detroit Edison Company, proved one of the chief contributions to the convention program. It dealt in striking form with the subject of relations between the company organization and the public. A cautionary note was sounded by Ernest Stenger, receiver of the Denver Tramway Company, who said that all utility companies could profit through the experience of electric railways and the errors of bygone days.

Herbert L. Metz, publicity manager of the supply department of the Western Electric Company, made a plea for better understanding of advertising by utility men. He said that advertising must not be understood as an exact science, that it is not static, and that to obtain proper results qualified persons must be employed. He urged greater consideration of direct mail advertising and the related use of customers' monthly service bills.

The address given by Grant E. Halderman, chairman of the Colorado Public Utilities Commission, on the certificate of public convenience and necessity proved unusually stimulating, and the appearance of Dr. S. K. Loy, Mayor of Casper, Wyo., on the program, lent a new point of interest, especially in his comparison of operations between public and privately owned utilities. To the latter he gave full credit, although he made the charge that most public service companies have too much red tape in dealing with the public. He added that the utility companies must reach down to the level of the majority of individuals served by them, observing that only 25 per cent of customers can really appreciate service.

National Electric Light Association headquarters were represented at the convention by W. A. Jones, treasurer, and George F. Oxley, director of publicity. An exhibit and several group meetings, supplemented by the address of K. A. McIntyre of the Society for Electrical Development, resulted in interesting two more states—Wyoming and New Mexico—and a number of additional central-station companies in the national better home-lighting contest.

New Officers

Officers elected in the division organization for the year starting next July are: President, Charles A. Semrad, commercial manager Public Service Company of Colorado, Denver; vice-presidents, Arthur Prager of Albuquerque, N. M.; Clare N. Stannard of Denver, and E. P. Bacon of Casper,

Wyo.; treasurer, A. C. Cornell; secretary, O. A. Weller. W. P. Southard, manager of the Trinidad (Col.) Electric Transmission, Railway & Gas Company, was re-elected president of the Colorado Public Service Association, Edward A. West vice-president and O. A. Weller was made secretary-treasurer.

A departure in arranging the convention was instituted this year by both organizations designating E. A. Phinney, president of the Jefferson County (Col.) Power & Light Company, as general chairman, with the special committees under his direction.

The Schools and the Campaign for Better Home Lighting

Varying success is being met in the effort being made by the Lighting Educational Committee to procure the indorsement of the better home-lighting movement by the school authorities. Opinions of school boards on the expediency of the schools lending their support to the educational campaign naturally differ. In Philadelphia, for instance, a flat refusal was encountered; but the local promoters of the effort, so far from being discouraged, immediately laid other plans for distributing the primers. Newspaper advertisements will announce that details of the contest can be had from any electrical store, and from these stores folders will be distributed giving a list of places where the primers can be had on October 1 in exchange for registration cards. In Chicago and other places similar plans are being followed.

Large cities where the school authorities have indorsed the movement are Detroit, Pittsburgh, Rochester, Omaha, Portland, Ore., and Memphis. In line also are Topeka, Kan.; Manchester, N. H.; Dallas, Fort Worth, Beaumont, Abilene, Amarillo and Marshall, Tex.; Erie, Johnstown, Sharon, Beaver Falls and New Brighton, Pa.; Knoxville, Tenn.; Waukegan, Lake County and Cook County (outside Chicago), Ill.; Three Rivers, Mich.; Baton Rouge and Caddo Parish, La.; Meridian, Miss., and Elkins, W. Va. The parochial schools in New Orleans and Detroit are also giving their support.

Periodicals which will carry advertisements of the campaign have now been selected to the number of twenty-one. Nearly all of these are magazines of national and very large circulation.

With more than two thousand communities, comprising a population of nearly forty million persons, entered in the contest, and with orders already filled for over five million pieces of literature, there can now be no further question that the contest will be presented in the right manner to the American and Canadian public. The figure for material will be doubled at least within the next two weeks.

George D. Shepardson, professor of electrical engineering, University of Minnesota, one of the international judges and an authority on illumination, is formulating standard rules for judging the essays. This form is being prepared so that the local judges throughout the United States and Canada will view the home lighting primers and essays in the same manner.

Additional subscribers to the Lighting Educational Committee's fund, bringing the number to sixty-six in all, are: L. Beyer & Company, Cleveland; Frankelite Company, Cleveland; E. H. Freeman Electric Company, Trenton, N. J.; Herwig Art Shade Lamp Company, Chicago; Phil R. Hinkley, Cleveland; Hubbard & Company, Pittsburgh; Kayline Company, Cleveland; Okonite Company, Passaic, N. J., and the Perfectlite Company, Cleveland.

Skagit Does Not Start

Delay Still Besets Seattle's Municipal Project—A Great Additional Outlay Contemplated

SHROUDED in mystery, beset by mishaps and rumors of mishaps, threatened with lawsuits and investigations, the Skagit municipal development of Seattle is still unproductive. President Coolidge was to have pressed the button on September 1, but this act was delayed, and the date was postponed to September 13. That day passed without action, and no new time has been set. In the interval water has been turned through the tunnel without the aid of the crib dam, the machines are being tested and construction of the crib dam has commenced.

An additional monkeywrench was thrown into the machinery of government when the City Council abandoned its proposed investigation into the responsibility for the 340-day delay in the completion of the tunnel after Chairman Russell of the Board of Public Works had informed it that C. F. Uhden, engineer of the Skagit project, would not be present. It would appear that the board resents the interference of the City Council with what it considers to be its statutory duties.

Completion of the crib dam is not expected for five to seven weeks, but operation of the plant will not be delayed on this account, it is declared. Some doubt has been voiced whether this type of dam will stand up under the freshets of the Skagit River. The next step in the complete development of the Skagit project calls for a masonry dam 240 ft. high.

The committee of the Council recommends that an additional outlay of $8,500,000 on the Skagit project, to permit of utilizing the Gorge Creek unit to its maximum, be made as soon as the Light Department can carry the extra expense. The committee points out that the present unit in the winter months will develop less than 50 per cent of its summer horsepower unless a storage dam is built at Ruby Creek. When the Skagit River, fed by glaciers, is running full during the summer, the dam will store up water for the winter months, it is pointed out, but unless the dam is built, the present unit will develop only about 25,000 hp. in winter. In summer, with water high, it will develop 55,000 hp. The proposed dam would store 1,300,000 acre-feet of water and permit 55,000 hp. all year.

Preliminary Permits Sought for Two Hydro Projects

An application for a preliminary permit has been filed with the Federal Power Commission by the Ventura Power Company of Wilmington, Del. The application covers a project in Piru Creek, a tributary of the Santa Clara River in California. It is proposed to erect two dams, one 210 ft. and the other 200 ft. in height, so as to create reservoirs of 53,000 acre-feet and 22,000 acre-feet respectively.

The Thompson Power Company of New York has applied for a preliminary permit covering a project on the Hiawasee River. It is proposed to erect two dams 90 ft. in height and one slightly lower, so as to develop 259,000 hp. One of the dams will be in Turtletown Creek. The project is located in Poke County, Tennessee, and Cherokee County, North Carolina.

Iron and Steel Exposition Scores Success

Pittsburgh Meeting of A. I. and S. E. E. Is Occasion for Notable Exhibits—Papers on Important Developments in Electrical Equipment—Inspection Trips

THE nineteenth annual convention of the Association of Iron and Steel Electrical Engineers at Pittsburgh on Monday to Friday of this week, September 15 to 19, was even more than usually successful. The exhibits of manufactures which have grown to be a big part of the convention were better and more representative than ever before and attracted a large and interested attendance. Fifty-six or more manufacturers had exhibit space at Duquesne Garden, and the latest equipment for the steel industry was demonstrated each afternoon and evening.

The technical sessions of the convention were well attended and contained a good variety of topics of interest to engineers. The latest developments made in adjustable-speed drives, combustion control, furnaces and other heat applications and allied subjects were treated. An innovation was the presentation of papers treating of the possibilities for greater co-operation between the central-station companies and the steel mills. M. E. Skinner and J. F. Mahoney presented the central-station aspects of this type of co-operation, and B. R. Shover gave an able paper on the power used in the iron and steel industry.

Inspection trips were taken to various steel mills and to the Westinghouse and other plants, and entertainment features and a dinner-dance afforded pleasure to members and visitors.

Alden C. Cummins, superintendent of the Electrical department of the Carnegie Steel Company, Duquesne, Pa., was elected president of the association in succession to R. S. Shoemaker of the American Rolling Mill Company, Middletown, Ohio.

A complete report of the meeting, containing abstracts of important papers, will be printed next week.

Rate Basis Crystallizing

Supreme Court Rulings, Selling Securities and Light Campaign Topics at Detroit

THE proper basis for utility valuation, experience with selling securities to consumers and local plans for tying in with the better home-lighting campaign were the chief subjects discussed at the concluding sessions of the Michigan Electric Light Association in Detroit last week.

In his paper on valuation F. A. Newton, Hodenpyl, Hardy & Company, declared that, as the outcome of United States Supreme Court decisions, there has never before been such unanimity of opinion regarding the basis for valuation of utility properties. Recent decisions by this court have not failed to place greater emphasis on the "cost of reproduction new" as a basis for valuation than on original or historical cost. To substantiate his statement Mr. Newton quoted from several decisions, notably those in the Southwestern Bell Telephone, Georgia Railway & Power and Bluefield (W. Va.) waterworks cases. The speaker contended that when first cost, working capital, going value and so forth are considered the proportionate weight given to each should be specifically announced.

Selling Securities to Customers

Experiences of three companies in selling securities to the public were related. A. W. Baldwin, Detroit Edison Company, referred to selling old issues at par and at market value, and also to the sale of new issues. Selling at par was made possible by holding a certain amount of stock and distributing not more than ten shares to each customer at $5 a share down and $5 a month. Another lot was sold by buying stock on the market for resale under similar terms but at market value. The company never buys back the stock but offers to assist customers to sell in the open market. New issues are sold through a local trust company. The selling is continuous and not spasmodic. The company now has 14,100 stockholders in Detroit territory.

Both employees and special security salesmen are used by the Consumers Power Company to make sales, according to the testimony of H. H. Koelbel. The employees are chiefly instrumental in discovering likely prospective buyers and the salesmen in closing the sales, the work being spread over twelve months, according to anticipated financial needs, instead of concentrated in a campaign of short duration. Prizes have been found more effective than remuneration and $3,285,000 worth of securities was sold last year, when a thousand employees participated. Various methods of instructing employees regarding the company and attracting the attention of the public were discussed in detail. By these methods the company had sold securities to the extent of $14,000,000.

Experiments in selling securities have been made by the Michigan Gas & Electric Company, declared P. B. Simons, to ascertain whether employees or special salesmen are better, with the result that employees are now used exclusively. Salesmen sold more, but with them there were more "comebacks" due to unauthorized promises. Mr. Simons favored the financing of extensions to small communities by sale of stock to the dwellers therein, the continuous daily sale of securities rather than sale by special campaigns, inviting the public to visit company plants and addresses before luncheon clubs.

Plans for participation in the better home-lighting campaign in three communities were outlined by H. D. Schall of Detroit, Mr. Litcher of Grand Rapids and P. B. Simons of Three Rivers.

Officers for the ensuing year were elected as follows: R. T. Duncan, president; F. D. Avis, first vice-president; P. B. Simons, second vice-president; Herbert Silvester, secretary-treasurer. Announcement was also made of invitations to Mackinac Island, Muskegon and Flint for the next convention.

Public Relations in New England

Last Week's Convention Showed that They Are Broadening in a Very Gratifying Way—Commercial and Technical Discussions—Getting Behind "New England Week"

IMPROVEMENT of public relations formed the keynote of the sixteenth annual convention of the New England Division of the N. E. L. A., which closed last week at Newcastle, N. H., with an attendance of four hundred. In addition to the proceedings reported on page 535 of the September 13 issue of the ELECTRICAL WORLD, a number of commercial subjects were treated comprehensively. These included an exposition of the plans of the better home-lighting contest by P. B. Zimmerman of Cleveland, a paper on the principles of rate making by Prof. T. H. Dillon of the Harvard Graduate School of Business Administration, a talk on "New England Week," on behalf of local manufactured products, by John S. Lawrence of Boston, several papers on appliance topics and various committee reports.

Fixed-capital records, credits, the preservation of records and merchandising overhead were discussed at a well-attended accounting session, and the usual technical session was devoted to automatic substations and the Fynn-Weichsel motor. The convention closed with a fine address on public relations by P. L. Thomson, manager publicity department, Western Electric Company, in which the speaker urged his hearers to lose no opportunity to tell the public about the aims and problems of utilities.

Bowen Tufts, Boston, advocated the co-operation of utilities in the furthering of "New England Week" by distributing publicity matter to customers. Mr. Lawrence declared that future utility executives will have to be good merchandisers. L. D. Gibbs, regional chairman of the better home-lighting contest, spoke of the widespread co-operation already received from school authorities and emphasized the high plane upon which the contest is being conducted. J. Daniels, Boston, said that only one school superintendent in the forty-two municipalities served by the Boston Edison company had refused to co-operate in the distribution of contest material to pupils.

A pointed plea for more consideration of the housewife's point of view in the design, manufacture and use of appliances was voiced by Mrs. E. Macdonald, field editor of *Modern Priscilla*. Too much emphasis has been laid upon drudgery in the home in appliance advertising, she said. Mrs. Macdonald recommended the establishment of a research laboratory under feminine direction to test appliances for domestic service. L. C. Pedlar, of Barton, Durstine & Osborn, New York, spoke on advertising as a factor in merchandising, and F. A. Belden, Portsmouth, N. H., described the successful use of all-electric cooking in the Hotel Wentworth, the convention hostelry.

H. B. Gilmore, Western Electric Company, Boston, for the contact bureau, outlined the successful local electric show developments of the past year in New England, which have improved public as well as trade relations. J. J. Caddigan, Boston, spoke on the Boston Edison company's "community electric shows," of which fifteen are to be put on in the coming year. A. G. Sias, manager Reading (Mass.) lighting department, testified as to the value of a local electric show, nearly fifty electric ranges having been sold on the departmental lines this year with about twenty electric water heaters. H. W. Derry, Hartford, said that good results have been obtained in his territory by turning over the detailed running of electric shows to local organizations like the American Legion or a women's society. Mr. Daniels said that two surveys of seventy-five new homes each showed an average of one extra outlet per room in the town where an electric home had been demonstrated.

Automatic Substations

Experience with automatic and supervisory substation service on the Malden (Mass.) Electric Company's system was contributed by L. R. Hicks, electrical engineer Charles H. Tenney & Company, Boston, in discussing papers on automatic substations by C. A. Butcher of the Westinghouse company and F. D. Wyatt, Cincinnati. Mr. Hicks reported little trouble with the relay equipment in the automatic installations, but said that the battery-charging equipment has been improved and that glass jars are being used in the later battery installations to insure easier inspection. False lamp indications gave trouble for a time in the supervisory installations. This was due to the distributor arm being out of step because of a worn clutch. In another case conditions were improved by installing a switch cutting off the battery from permanent connection with the control key. Small leaks of current due to spilled electrolyte were

sufficiently powerful to operate relays, currents as low as 0.002 amp. giving trouble in this way. In the newest installation at Malden provision will be made to indicate when the supervisory control is not in order, and there will also be an out-of-step relay with a bell whose tapping will vary in frequency according to the phase situation.

T. E. Penard and R. E. Dillon, Boston, outlined the design of a new 15,000-kw. substation of the automatic type to be built in the West End district, and C. R. Oliver, assistant general manager New England Power Company, recounted the success of the 5,000-kw. automatic hydro-electric station of that company at Searsburg, Vt. A study is being made of the practicability of making the company's plants at Shelburne Falls, Mass., semi-automatic. Chester Lichtenberger, General Electric Company, described the operation of the automatic substations at Kansas City. More than 20 per cent of the energy transmitted has been saved by increasing the feeding-in points.

E. W. Goldschmidt, New York, Wagner Electric Manufacturing Company, closed the technical session by analyzing the sphere of application of the Fynn-Weichsel motor.

Mr. Davis Speaks on Colorado River Development

Speaking at Denver last week, John W. Davis, Democratic candidate for the Presidency, dealt especially with Western problems, criticising the federal government for what he held to be an inadequate irrigation policy and referring to Colorado River development in these terms:

"While the development of our country and the progress of our people are best served through encouragement of individual initiative, there are certain activities which by reason of their peculiar national character can be more satisfactorily and expeditiously carried out by the national government. The improvement and development of the great Colorado River, which flows through your own state, illustrates the policy I have in mind. That river is an international as well as an interstate stream. It possesses the latent power to enrich all of the Intermountain States through which it flows. It may be used to irrigate millions of acres of the richest soil and can develop a tremendous horsepower that will reduce the cost of production upon the farms and any other industry within its broad basin.

"Yet, great as may be its potentiality for hydro-electric power, it has its limits, and these limits will be unfortunately reduced unless the development is carried out in such a way that the maximum benefit for all will be obtained. I do not favor the operation of power plants and the distribution of electricity by the government. This may well be done by private enterprise after the necessary dams have been constructed. But it seems to me that in this case the government should determine the location of these dams and the character of their construction and that such construction should be actually carried out by it."

To Assail Power Board

Advocates of Public Ownership Hold that It Nullifies Municipal Priorities of Law

AN EARLY attack on the Federal Power Commission from the advocates of public ownership of utilities is looked for at Washington. The movement has its principal support in California, where it is contended that the commission is entirely hostile to public ownership and has nullified the prior rights granted in the act to municipalities.

It is contended further that the attitude of the commission revealed at the hearings on the Swing-Johnson bill is that the whole conception of the Boulder Canyon Dam on the Colorado River is an experiment in public ownership. This assumption is probably correct. The commission has learned that it is the ambition of certain individuals to build up in California a hydro-electric commission like that in Ontario. If California thinks it can find the Sir Adam Beck and is willing to undertake a development on the Colorado which will fit into a general plan for the utilization of the full resources of the stream, and would be willing to finance its experiment itself, it is regarded as entirely probable that the Federal Power Commission would be willing to grant the necessary license and assist in every way to make the development a success. It is very evident, however, that the financing out of the United States Treasury of developments within states conflicts with the policy of the commission.

It also is very evident that the commission believes that private development of power is more likely to be successful than are municipal or state schemes, owing to the fact that under the latter extensions, rates and policies would be subject to political control, which frequently deviates from the path which would be chosen by private enterprise. It is believed that the three Cabinet members making up the commission would hold similar views with regard to any excursion of the public into business. There is every reason to think, however, that they will be perfectly willing to aid any municipal or state project where the public agency is ready to finance its own project.

Program of American Electric Railway Convention

Among the proceedings of interest to electrical men outside as well as inside the electrical railway industry which will form part of the program of the annual convention of the American Electric Railway Association, to be held at Atlantic City in the week beginning October 6, will be a discussion on customer ownership on Tuesday, October 7, in which C. W. Kellogg of Stone & Webster, Boston, and Fred Scheel, vice-president of the Utility Securities Company, Chicago, will take the chief part. On Thursday, October 8, Robert G. Gordon of Louisville will give a paper on Muscle Shoals. On the same day, before the Engineering Association division, reports will be presented from the committees on power generation and conversion and on power transmission and distribution, as well as the report of a special committee on automatic substations.

Empire State Association's Annual Convention

Arrangements for the annual convention of the Empire State Gas and Electric Association, to be held at the Lake Placid Club, N. Y., October 6 and 7, have been about completed. The business program follows:

MONDAY, OCTOBER 6

Morning.—President's address, Sanford J. Magee; reports of officers and committees; address, "Training of Employees for Public Utility Service," Arthur Williams, New York Edison Company; address, "The Social Significance of Gas and Electric Service," Mrs. Rosalie Loew Whitney, former member of the New York State Industrial Commission.

TUESDAY, OCTOBER 7

Morning.—Report of accounting committee; report of New York State Committee on Public Utility Information, M. S. Sloan chairman; report of woman's section, New York State Committee on Public Utility Information, Mary E. Dillon chairman; address, "Truth in Advertising," Harry D. Robbins, Associated Advertising Clubs of the World; election of officers.

The annual banquet will take place Monday evening and will be followed by the president's reception. Headquarters will be at the Lakeside Club House.

Argument Filed at Olympia, Wash., Against Bone Bill

An argument against the so-called Bone free-power bill, to be submitted to the voters of Washington State in November, has been filed at Olympia by Senator William Bishop of Jefferson County, a leading farmer and dairyman. In this argument Senator Bishop says in part:

"When the Bone bill was introduced at the last session of the Legislature it merely empowered cities owning municipal plants to sell their surplus light and power outside their limits. . . . An investigation was made by the Department of Taxation and the Department of Public Works of the state, and it was found that the light and power companies were paying over 9 per cent of gross earnings in taxes, thus helping to carry the tax burden for state, school, road, county and municipal and all other purposes. . . .

"Initiative Measure No. 52 is not the same measure introduced by Mr. Bone at the last session of the Legislature. It grants to the cities not only the right to sell electric light and power outside their city limits, but gives to such cities the power to condemn all existing light and power properties. I have every reason to believe that these sections were written into the measure for the purpose of having the cities exercise them if the bill is passed. This would, of course, take from the tax rolls properties which are today paying a large amount in taxes every year. This would necessarily throw a heavier burden of taxation upon all other property. . . . Initiative No. 52 appears to be another plan to make the rest of the state pay through increased taxes for more experiments in municipal ownership."

Great Lakes N. E. L. A. French Lick Program

For the fourth annual meeting of the Great Lakes Geographic Division, N. E. L. A., to be held at French Lick Springs, Ind., on Thursday to Saturday of next week, September 25-27, immediately following the sixteenth annual meeting of the Indiana Electric Light Association on Wednesday, September 24, the program is as follows:

THURSDAY, SEPTEMBER 25

Morning.—President's address, Marshall E. Sampsell; reports of Public Relations Section (B. F. Lyons) and women's public information committee (Mrs. P. W. Evans); "Women and Public Utilities," Miss May S. Fletemeyer; address, Miss Ethel M. Westenhaver; "Public Acquaintance," Miss Mabel W. Miller; address, H. G. Taylor; "On the Other Side of the Atlantic," B. J. Mullaney; symposium—"Sale of Securities"; "Ethics and Methods," Fred H. Scheel; "Advertising," Paul Young; "Contact After Purchase," F. W. Hoover.

Evening.—Banquet; speakers, Franklin T. Griffith, Martin J. Insull and M. H. Aylesworth.

FRIDAY, SEPTEMBER 26

Morning.—Report of insurance committee, Robert Davey; "The Accurate Control of Materials and Supplies," H. W. Duncan; report of power survey committee, R. F. Schuchardt; "Comparative Costs of Electric and Fuel Furnaces," C. H. Stevenson; "The Better Home-Lighting Activity," J. E. Davidson with discussion by John F. Gilchrist, Frank J. Haas, G. C. Neff, S. B. Tuell and Bert H. Peck; "Domestic Electric Refrigeration," A. D. McLay; "Advertising by Central Stations," Donald Mackie; "New Era in City Transportation," Robert Fitzgerald; "Rural Lines and Their Relation to Agriculture," E. Holcomb and Dr. E. A. White.

Evening.—"Electrical Advertising," James M. Gilchrist and others; N. E. L. A. convention film; address, Miss R. E. McKee; motion pictures.

SATURDAY, SEPTEMBER 27

Morning.—Reports of accident prevention committee (H. J. Burton) and educational committee, John H. Mitchell; "Business Correspondence," J. F. Rice; report of meter committee, J. E. Miller; "Loading of Distribution Transformers," Harold Cole, with discussion by B. L. Huff; "Steam-Plant Design," H. F. Eddy, with discussion by George C. Daniels; "Transmission Tower-Line Engineering and Construction," F. E. Andrews, with discussion by Harold Cole.

A full program of sports and entertainment will be provided. The Indiana Electric Association at its meeting will hear President F. J. Haas, Dr. E. A. White and William L. Goodwin.

De Forest Company Sues to Annul Armstrong Patent

Speaking at a testimonial dinner to retiring officials of the De Forest Radio Telephone & Telegraph Company in New York last week, S. E. Darby, Jr., the patent attorney of that company, gave an account of the litigation that has followed De Forest's application in 1914 for patents on the regenerative, or feed-back, circuit used in connection with his three-electrode audion, or thermionic vacuum tube, which the speaker described as "the heart and soul of present-day radio." Mr. Darby told how the United States Court of Appeals of the District of Columbia had on May 5 last unanimously decided that De Forest had priority rights to the two patents involved, thus upsetting five concurring decisions, three in the Patent Office and two in the United States courts. The District of Columbia Court of Appeals is the court of last resort in patent cases, and two weeks ago, in accordance with its finding, the patents (Nos. 1,507,012 and 1,507,016) were finally issued to Dr. De Forest and assigned by him to the De Forest Radio Telephone & Telegraph Company.

The De Forest company has now filed suit, Mr. Darby said, in the United States District Court of Pennsylvania against the Westinghouse Electric & Manufacturing Company as owner of the patent of Edwin H. Armstrong, which had furnished the subject for priority litigation, asking for a court decree invalidating the Armstrong patent. A law, he explained, had been passed to meet just such a case, but it has been invoked only three or four times.

Briefer News

Radio Conference Postponed. — The Department of Commerce announces that the date for the third national radio conference at Washington will be Monday, October 6, instead of September 30, as at first intended.

Still Another Merger in New York State.—The Fulton County Gas & Electric Company of Gloversville, N. Y., has recently purchased the Middleburg & Schoharie Electric Light Company, also the Great Bear Electric Light Company, at East Worcester and Schenevus, and the Worcester Electric Light Plant, all of which purchases have been referred to the Public Service Commission for approval.

Sanford, Fla., Refuses Offer of Utility Company to Sell Plant to City.—The City Commission of Sanford, Fla., has rejected the offer of the Southern Utilities Company to sell its electric light and power plant and all property used in connection therewith for $920,000. An appraisal of the property is being made by an engineer, after which a definite offer is to be made for the plant. Then, if the city's offer is rejected, it will, according to the Mayor, build a plant of its own.

Two Oregon Companies Are Merged.—Announcement has been made of the purchase of the properties of the Stayton (Ore.) Light & Power Company by the Mountain States Power Company of Albany, Ore. The schedule of rates prevailing at Stayton has been adopted by the purchasing company. Though the exact point of contact has not been determined, it is said that the Stayton system will be tied in with that of the Mountain States Power Company by an 11,000-volt line.

New Barstow Plant Will Be Located Near Gaffney, S. C.—It is understood that the W. S. Barstow Management Association, new owner of the South Carolina Gas & Electric Company of Spartanburg and of the public utilities in Columbia, S. C., has decided to locate its new two-million-dollar steam plant near Gaffney, though the site has not been definitely selected. E. M. Gilbert of Reading, Pa., vice-president of the Bartsow organization, has been making an intensive study of the country, aided by engineering experts and other company officials. He is quoted as saying that the company will not stop with the erection of this plant, but that other expansions and improvements will be started as fast as they are warranted.

California Electric Companies' Net Operating Revenue for 1923.—The annual 1923 reports of all public utilities operating in California have recently been compiled by the Railroad Commission of that state. The operating revenues of all electric light and power companies for the year named were $75,541,683 against $69,322,631 in 1922; operating expenses, $35,946,413 against $40,048,764 in 1922, and net operating revenue, $39,595,270 against $29,273,867.

Hydro-Electric Power in Northern Ontario.—An agitation in favor of the Ontario Hydro-Electric Power Commission's at once taking over and developing the power resources of the northern Ontario mining regions is being waged in the province named on the ground that unless this step is taken the power situation in the north will be dominated "for all time" by agreement between the three largest producers there—the Hollinger power concerns, the Northern Canada Power Company and the Abitibi Power & Paper Company.

Railroad Electrification on Staten Island. — Electrification of approximately 17 miles of double-track passenger line of the Staten Island (N. Y.) Rapid Transit Company and the Staten Island Railway Company is now under way, an order having recently been placed with the General Electric Company for eighty equipments each including two 200-hp. motors. Trains of from two to ten cars can be operated from one controller with a maximum speed of approximately 50 miles per hour. Energy will be supplied through a top-contact third rail. The Staten Island Rapid Transit Railway Company operates between St. George and South Beach and the Staten Island Railway between Clifton Junction and Tottenville. These places are all in Richmond Borough, New York City.

Electrical Extension in Northern Minnesota.—A large force is engaged in the erection of the Minnesota Power & Light Company's 110,000-volt transmission line between Blanchard Rapids, south of Little Falls, on the Mississippi River, and Nashwauk. The hydro-electric station of the company now under erection at Blanchard is expected to be in operation early next year. It utilizes a fall of 45½ ft., and it is planned for a rating of 25,000 hp., of which about 16,000 hp. is at present developed. The transmission line will cross the Cuyuna range at Riverton, where it will be connected up with the Little Falls-Cuyuna division distribution system, and from

there it will run to Nashwauk, where it will be tied in with the transmission lines of the company's Mesaba range division. The power company has also a large crew engaged in extending its lines in the Minnesota-Vermilion Lake district. An extension is being made to Tower and a substation will be placed at Soudan, Minn. The pole line has reached Soudan and will probably be completed to Tower within sixty days. The entire program of the company will, it is said, cost more than $3,000,000.

The First British Automatic Substation.—What is described as the first automatic substation in the United Kingdom has been erected in conjunction with the extension from Hendon to Edgware, a distance of between 3 and 4 miles, of the London, Golders Green, Hendon Tube Railway, which was opened for traffic last month. The power for working the line is generated at the Underground Railway Company's power house at Chelsea, alternating current at 11,000 volts being transmitted to the automatic substation at Burnt Oak, where it is transformed and converted into direct current at 600 volts for supply to the track to Edgware. The substation is controlled from the master-control apparatus at Golders Green, about 6 miles away.

Public Utility Courses at Philadelphia.—The University of Pennsylvania and Temple University, Philadelphia, will establish courses in the operation, economics and regulation of public utilities in October. The courses have the indorsement of the executive committee of the Pennsylvania Public Service Information Committee. Each course will be given under the guidance of technical experts from the various branches of the public utility industry and will be made especially available to men engaged in the electric, telephone, gas, street-railway and water-supply business. The course in central-station engineering at Temple University comprises fifteen lectures by such men as P. H. Gadsden, M. H. Aylesworth, J. E. Zimmermann, C. J. Russell and W. H. Johnson.

Third Turbo-Generator Now in Service at Cahokia.—The General Electric Unit No. 3 has been placed in service at the Cahokia plant of the Union Electric Light & Power Company, on the Illinois side of the Mississippi. This machine is the first of the two units of the second section of the station and brings its rated capacity to 90,000 kw. Experiments have been made in the furnaces at Cahokia on burning pulverized petroleum coke. This material is a by-product of the oil-refining industry and has hitherto been considered a waste. Should it prove to be successful it will furnish a desirable addition to the regular coal supply. Belleville bituminous coal, which is unsatisfactory as a stoker-fired fuel, is being used in the pulverized form quite well. The dredging for the third section of the Cahokia plant is making good progress.

El Paso Company to Reach Out for a Hundred Miles.—Plans for the construction of an extensive electric power transmission system for the valley of the Rio Grande below El Paso have been prepared by the El Paso Electric Railway Company, subsidiary of the Stone & Webster Engineering Corporation of Boston, and have been sent to the latter for approval. The company, as previously reported, is already extending its power system for El Paso northwest to Las Cruces, N. M., 42 miles, supplying Canutillo and other towns on the route, and current for this section of the line was turned on a week or two ago. When the work which is now projected is finished the towns and industries in a stretch of the valley nearly a hundred miles long will be supplied with electric power and light from the central station in El Paso. The extension of the lower valley line is to run from Ysleta by Socorro to San Elizario, from where it will run eastward to the state highway and into Fabens. A branch line will go from the vicinity of San Elizario to Clint. Another line is to run to Tornillo.

Coming Meetings of Electrical and Allied Societies

[A complete directory of electrical associations is published in the first issue of each volume. See July 5 issue, page 50, for latest list.]

Great Lakes Division, N. E. L. A.—French Lick, Ind., Sept. 24-27. R. V. Prather, Illinois Mine Workers' Bldg., Springfield, Ill.

Electrical Supply Jobbers' Association, Pacific Division—Del Monte (Del Monte Lodge, Pebble Beach), Cal., Sept. 25-27. Albert H. Elliot, 502 Flatiron Bldg., San Francisco.

Safety Congress, National Safety Council—Hotels Brown and Seelbach, Louisville, September 29-October 3.

Association of Electragists International—West Baden Springs, Ind. Sept. 29-Oct. 4. L. W. Davis, 15 West 37th St., New York.

American Electrochemical Society—Hotel Fuller, Detroit, Oct. 2-4. Colin G. Fink, Columbia University, New York.

American Electric Railway Association—Atlantic City, N. J., Oct. 6-10. J. W. Welsh, 8 West 40th St., New York.

Empire State Gas and Electric Association—Lake Placid Club, N. Y., Oct. 6-7. C. H. B. Chapin, Grand Central Terminal, New York.

American Institute of Electrical Engineers—Pacific Coast convention, Pasadena, Cal., Oct. 13-17. F. L. Hutchinson, 33 West 39th St., New York.

International Association of Municipal Electricians—Partridge Inn, Atlanta, Oct. 14-17. W. R. Arbuckle, Bayonne, N. J.

Electric Power Club—Greenbriar Hotel, White Sulphur Springs, W. Va., Oct. 20-23. S. N. Clarkson, B. F. Keith Bldg., Cleveland.

Kansas Public Service Association—Broadview Hotel, Emporia, Kan., Oct. 24-25. R. T. Smalley, Kansas Electric Power Co., Emporia.

Illuminating Engineering Society, Briarcliff Manor, N. Y., Oct. 27-31. N. D. Macdonald, 29 West 39th St., New York.

National Association of Railway and Utilities Commissioners—Phoenix, Ariz., Nov. 11-14. James B. Walker, New York Transit Commission, New York.

West Virginia Public Utilities Association—Charleston, W. Va., Nov. 14-15. Bliss McCrum, secretary.

Electrical Credit Association (Middle and Atlantic States)—Philadelphia, Nov. 14. F. P. Rose, Marquette Bldg., Chicago.

Electrical Supply Jobbers' Association—Hotel Cleveland, Cleveland, Nov. 19-21. Franklin Overbagh, 411 South Clinton Street, Chicago.

New Service for Imperial Valley.—By the recent completion of the 88-mile transmission line of the Southern Sierras Power Company between El Centro and Rincon about 5,000 kw. from the tidewater steam plants of the San Diego Consolidated Gas & Electric Company was through interconnection made available for use in the Imperial and Coachella Valleys and the Riverside district. The new interconnection, which with transformers, equipment and the rebuilding of part of the old line for 85,000 volts cost approximately $800,000, is designed to furnish standby and emergency service to the Imperial Valley, but during the present shortage in hydro-electric power it may be used to supplement the power supply so far as possible throughout the Southwestern territory.

National Electrical Code Approved.—The "Regulations for Electric Wiring and Apparatus in Relation to Fire Hazard" of the National Fire Protection Association, generally known as the "National Electrical Code," 1923 edition, have been approved by the American Engineering Standards Committee. A list of eighty-five symbols for use in wiring diagrams for buildings has also been approved by the committee. The symbols are the work of a sectional committee under the joint sponsorship of the American Institute of Architects, the American Institute of Electrical Engineers and the Association of Electragists International. The present standard is a revision and a considerable extension of the list first compiled by the National Electrical Contractors' Association in 1906. During the work approximately three thousand symbols were submitted to the sectional committee, of which C. Kaiser and Farquson Johnson are chairman and secretary respectively.

Lhasa, Thibet, Wakes Up.—The Sacred City of Lhasa in Thibet, where lamas grand and small hold sway and from which foreigners are rigidly excluded, is about to install its first electric plant, an Armstrong-Whitworth water turbine directly coupled to a Crompton three-phase alternator rated at 125 kva., 500 volts, 40 cycles and 1,200 r.p.m., which is excited by a 20-kw. generator producing direct current at 220 volts. According to the *Electrical Times* of London, this apparatus is to be carried on mule back up the 11,800-ft. elevation from which Lhasa looks down and is to be erected by natives who have watched its construction in England assiduously. No European engineer will be allowed to take part in assembling the plant. After all, the *Electrical Times* admits, Lhasa is not the only city that has been lacking in a proper appreciation of electricity, for Boston, England, with 17,000 inhabitants, is erecting its first central station, having up to this

time had no bulk supply of any kind, though it could boast several private plants.

Edison Association Re-elects Officers.—All the officers of the Association of Edison Illuminating Companies were re-elected at its New London convention last week, as follows: President, John F. Gilchrist, Chicago; vice-president, Samuel Ferguson, Hartford; treasurer, H. P. Liversidge, Philadelphia; secretary and assistant treasurer, Preston S. Millar, New York.

Ninety-three Millions Invested in Electric Light and Power Plants in Western Canada.—One of the noteworthy features of a government report, just issued, dealing with the growth of manufacturing plants in Western Canada, and especially in the prairie provinces, is the extent to which electric light and power plants figure in the total investment. Out of a total capital investment of a little more than $333,000,000, they represent $93,000,000. In all four provinces the proportion of capital investment in these plants as compared with that in all industries stands at about the same ratio. In Manitoba it is approximately 27 per cent, in Saskatchewan about 30 per cent, in Alberta 27 per cent and in British Columbia 24 per cent. In all four provinces more money is invested in electric light and power plants than in any other form of industry. In Manitoba they represent $23,000,000 out of $84,662,000; in Saskatchewan, $8,000,000 out of $30,268,000; in Alberta, $14,000,000 out of $51,000,000, and in British Columbia, $48,000,000 out of $200,192,000.

Portland Company Increases Boiler Capacity.—Additional boiler capacity to increase the kilowatt-hour output and to furnish more steam for the increasing heating business is the aim of a three-hundred-thousand-dollar improvement to the Lincoln Street steam plant of the Northwestern Electric Company, Portland, Ore. A new building is being built to house two 1,000-hp. Stirling boilers which will be added to the six present boilers of 4,932 hp. at this plant. This addition will provide enough energy to operate to full capacity the two 10,000-kw. turbo-generator units in the plant and furnish enough steam to heat the entire downtown district of Portland, where the company's steam-heating business is concentrated. The steam heat generated in the plant is transmitted one and one-half miles underground to the center of its application. This is said to be the longest high-pressure steam line in the United States.

Who Will Buy New York's State-Owned Power?—At Albany, N. Y., the question is asked, who will buy the 16,000 hp. of hydro-electric energy to be generated next year by the state-owned plants at Crescent Dam and Vischers Ferry on the Barge Canal? The law as passed in 1922 authorized sale to the highest bidder. By an amendment passed last year electricity may be sold only to municipalities, and it is averred that at the present time there is no municipality in the capital district equipped with a distribution system. Even were the original provision of the law restored, difficulties would be met. The Municipal Gas Company of Albany supplies 40-cycle energy, and for it to avail itself of the state's 60-cycle supply would necessitate an approximate expenditure of $190,000 for a frequency changer. Troy and Cohoes also use 40-cycle energy. The Adirondack Power & Light Corporation, however, distributes its energy mostly at 60 cycles.

Recent Court Decisions

Reading to Jury from Standard Books on Electricity Held Prejudicial in Damage Case.—Topmiller vs. Kentucky Public Service Company was a damage suit brought by the widow of an ice merchant who was electrocuted while trying to turn a switch installed near the ice box, where the ground was usually wet. It was shown that a stroke of lightning had destroyed a transformer in a hotel near by, and the plaintiff held that for this reason the transformer in the ice merchant's plant had been made unsafe. A verdict of $25,000 for the plaintiff was rendered, and exception was taken to the Court of Appeals of Kentucky on several counts. The court has held that under the circumstances testimony about the hotel transformer being struck was properly admitted, and also that evidence that a testifier had been associated with an electric light company, had superintended installations and had studied electricity was sufficient to qualify him as an expert witness. None the less, the court reversed the judgment and remanded the case, largely because it held that the lower court had erred in permitting quotations from technical books to be read to the jury upon testimony that they were standard authority. Such books are inadmissible in evidence, the court said, though an expert may be contradicted by reading such works to him on cross-examination. (263 S. W. 706.)*

Is a Farmers' Association Supplying Electricity to Members a Utility?—The case of Schumacher, the Manitowoc Construction Company and the Lincoln Highway Light Company vs. the Wisconsin Railroad Commission, which has aroused much interest in Wisconsin and is said by the chairman of the commission to "strike at the very heart of utility supervision" in that state, has been adjudicated in the Superior Court, which sustained the finding of the Circuit Court. (See ELECTRICAL WORLD, September 23, 1922, page 683; May 5, 1923, page 1058, and January 19, 1924, page 161.) The suit, which will be carried to the Supreme Court of the state, involves an attack on the authority of the commission to regulate operations of mutual utility firms. The Superior Court, following the court of first resort, holds that the Lincoln Highway Light Company does not come under the law authorizing the commission to regulate public utility companies. "The case presents the fundamental question whether the plaintiffs are in fact such an association of individuals as to constitute a public utility within the meaning of the statutes," the court says. "If they are not a public utility, the defendant commission had no jurisdiction over them and all its orders in this matter are without jurisdiction and void. The plaintiffs are in no sense a public utility. They are only a group of neighbors who have co-operated to build a line to supply themselves with electric current, with no purpose of making a profit or of serving the public generally or any portion of the public outside those who voluntarily band themselves together to aid this purely neighborhood co-operative undertaking. The Legislature never contemplated that such an association would be considered a public utility, subject to the regulations of the Railroad Commission." The court therefore ordered that the ruling of the commission directing a settlement of a dispute over electric rates of the Lincoln Highway firm be set aside and vacated. Several hundred similar companies, hitherto regulated without question by the commission, would, it is said, be exempted from its control by this decision.

*The left-hand numbers refer to the volume and the right-hand numbers to the page of the National Reporter System.

Commission Rulings

Rule Governing Graduated Schedules.—Declaring that it has the power to require the establishment of classifications of service, the New York Public Service Commission declared in a case affecting the gas rates of the Rochester Gas & Electric Corporation that a graduated schedule of rates under which large consumers obtain a lower rate is in the best interests of the public when the rates cover the cost of the commodity in quantities as used and produce the required revenue.

Utility Not Compelled to Make Unprofitable Extensions.—In adjudicating a complaint made by the city of Yonkers to compel the Westchester Lighting Company to make an extension of its gas mains, the New York Public Service Commission said that a company cannot properly be required to make an extension unless it shall appear that the revenues to be derived immediately or within some reasonable period will be such as will be substantially compensatory to the company for the investment and operating expenses involved in providing the extension and the service. A provision in a contract between a city and a utility for furnishing additional street lighting does not require the utility to extend its system in order to furnish service to present or prospective consumers.

Men of the Industry

W. A. Durgin Director of Public Relations in Chicago

William A. Durgin, who recently rejoined the Commonwealth Edison Company of Chicago after spending two and a half years with the Department of Commerce in Washington, has been appointed director of public relations for the company. Mr. Durgin has been affiliated with the Commonwealth organization since 1904, when he entered its testing department, remaining there ten years, specializing in studies on

W. A. DURGIN

underground cables and alternating motors. After serving as lighting specialist from 1914 to 1919 he was promoted to the post of lighting assistant to the vice-president. In 1920 he was made secretary of the budget and expense committee and of the advisory committee of the company. It was in December, 1921, that he obtained a leave of absence to direct the work of furthering the elimination of waste by the simplification of commercial practices. These duties he has relinquished to take up duties again with the Commonwealth company.

Donald C. Barnes, manager of the central division of the Puget Sound Power & Light Company, Seattle, has been made a new vice-president of that company. Mr. Barnes has been an official in the company's organization for more than twelve years.

William S. Hake, Rochester, N. Y., illuminating engineer, has become president and treasurer of the F. & F. Electric Service Company, Jamestown, N. Y.

Richard M. Boykin, manager of the southern division of the Puget Sound Power & Light Company, Portland, Ore., has been appointed manager of the central division of that company to succeed D. C. Barnes, recently made a vice-president. An account of Mr. Boykin's career was published in the July 19, 1924, issue of the ELECTRICAL WORLD upon his election to the presidency of the Northwest Electric Light and Power Association.

Farley Osgood, vice-president and general manager of the Public Service Electric & Gas Company, Newark, N. J. and president of the American Institute of Electrical Engineers, has severed his connection with the former organization, effective October 1. Mr. Osgood has announced no definite plans.

Thomas J. Brown of Charleston, Mo., has been appointed chairman of the Missouri Public Service Commission by Governor Arthur M. Hyde to succeed Merrill E. Otis of St. Joseph, Mo., who resigned on Aug. 15 to take up the practice of law in St. Louis. Mr. Brown has been a member of the commission since July, 1923.

Miss Olive A. Bursiel, who has been secretary of the New England Division of the National Electric Light Association for nearly its entire life, was presented with a box of gold coins at the sixteenth annual convention of the division held last week at the Hotel Wentworth, Newcastle, N. H. The gift was made up of a large number of individual remembrances in appreciation of her loyal and enthusiastic service in helping to build the division to its present membership of about 1,500, and of her competent administration and vision of public utility progress attainable through national and local activity. Past-president Bowen Tufts was master of ceremonies.

G. B. Buck, formerly new-business manager of the Durham (N. C.) Public Service Company, has been transferred to the recently organized new-business department of the Public Service Company of Colorado. Mr. Buck will be in charge of all new-business work in the domestic and commercial electric division. Mr. Buck's association with the new-business department of the Doherty interests covers a period of eleven years. Starting as a representative of that department at Mount Vernon, Ill., he later became manager and subsequently was transferred to the City Light & Water Company, Amarillo, Tex., as new-business manager. In 1917 he joined the North Carolina property.

T. B. Wilson New Manager in Louisville

T. B. Wilson, the new general manager of the Louisville (Ky.) Gas & Electric Company, has been identified with the electrical industry since his youth, when in 1896 he took his first position as assistant dynamo tender with the old Citizens' General Electric Company at Louisville. During the following years he progressed rapidly in the company's ranks, being made successively dynamo tender, collector and meter reader and serving in various other capacities. In 1905 he was elected secretary and treasurer of the Louisville Lighting Company, and after the merger of the properties at Louisville with the Byllesby organization in 1913 he was appointed assistant general manager of the consolidated properties. Last year Mr. Wilson was elected a vice-president of the company.

T. B. WILSON

Obituary

Arthur S. Huey, chairman of the board of directors of H. M. Byllesby & Company, died of pneumonia at the South Shore Country Club, Chicago, September 16, after an illness of only a few days. Mr. Huey had been closely identified with the electrical industry since 1885 and had been a prominent figure in the operation and management of Byllesby properties since 1902. Born in Minneapolis in 1862, he received his education in the public schools of that city and following graduation learned the trade of printer, which he never followed. After several years' association with the management of theaters in his native city, he was appointed in 1885 a representative of the United Edison Company, a manufacturing concern in Minneapolis. In 1891, the year of the consolidation of the Edison company with the Thomson-Houston company Mr. Huey affiliated himself with the Northwestern General Electric Company at St. Paul, for a long period being in charge of that office. When the firm of H. M. Byllesby & Company was organized in 1902 he became one of the partners and was made vice-president in charge of operation. In this capacity Mr. Huey supervised the operation of about twenty groups of utility properties. In the spring of the present year he was elected chairman of the board to succeed the late Henry M. Byllesby.

Edward C. Platt, vice-president and treasurer of the Mackay Companies and the Postal Telegraph-Commercial Cable System, died suddenly of heart disease in his apartment in the Hotel St. George, Brooklyn, N. Y., September 15. Mr. Platt was a native of Mobile, Ala., and had been treasurer of the Mackay Companies system since its formation in 1883.

Financial and Corporate

Utility Prices Higher

American Light & Traction Company and Middle West Utilities Lead the List

WHILE the general trend of the unlisted market in utilities still is upward, a compilation of net changes of representative issues for the past week shows that some issues have reached a point where advances are not so rapid or so sensational as before. Commonwealth Power Corporation shares, for example, which for a long time have been a leader in the advance, actually lost ground. Small losses likewise were taken by such stocks as Virginia Power, Carolina Power & Light, Adirondack Power & Light and Northern Ontario Light & Power.

With these exceptions the majority of significant changes for the week represent advances. American Light & Traction shares, which had not received any particular attention in recent weeks, suddenly turned strong and moved from 118½ to 133 on encouraging news from Detroit. The recent election showed that 53 per cent of the people were in favor of the ordinance on gas rates and, while that fell short of the required 60 per cent vote, it nevertheless was interpreted as distinctly favorable market news. The next best gainer for the week among the more important stocks was Middle West Utilities. This Insull issue, which sold earlier in the year at 41, is getting up to a level almost double that figure and holds the ground well as it advances. The Middle West Utilities Company has opened an office in New York recently to acquaint investors with its properties, but the improvement in the stock has no direct bearing on that. It seems to be due to accumulation on the part of those who have been following the earning prospects closely.

Outside of these issues the actual price changes are not particularly large, but there has been considerable interest in the Continental Gas & Electric issues, General Gas & Electric issues and some of the lower-priced stocks, such as Power Securities Corporation.

Middle West Utilities Opens New York Office

In order to facilitate the sale and distribution of the dividend-paying preferred and prior lien stocks of the Middle West Utilities Company and its numerous subsidiary companies, this Insull holding organization has been instrumental in the formation of a new company to be called the Middle West Utilities Corporation. The Middle West Utilities Corporation, as distinguished from the Middle West Utilities Company, has opened an office at 111 Broadway, New York. The corporation is a selling organization for the company in this territory. Samuel Insull is president of the Middle West Utilities Corporation, Martin J. Insull is vice-president, and General J. A. Ryan is vice-president and general manager. Mr. Ryan is in charge of the New York office.

Fifteen-Million-Dollar Issue Feature of Week

The outstanding feature of electric light and power financing during the week ended September 16 was the fifteen-million-dollar issue of 7 per cent preferred stock which has been authorized by the board of directors of the Columbia Gas & Electric Company and offered holders of common stock in the proportion of one share for each ten shares already held. The funds obtained from the sale of this stock will be used to reimburse the treasury for capital expenditures already made, to meet early maturing obligations incurred for additions to the properties and to provide funds for other purposes. Several other offerings of preferred stock were made, including General Gas & Electric Corporation 8 per cent cumulative preferred stock to the amount of $1,575,000, offered at $105 and yielding 7.62 per cent; Central Illinois Public Service Company stock amounting to $85,000, offered at $85 per share, and Coast Valleys Gas & Electric Company stock, amounting to $250,000 and yielding 7 per cent. The only offering of bonds was made by the Public Service Company of Oklahoma to the amount of $3,275,000 in first mortgage twenty-five-year gold bonds. The Terre Haute, Indianapolis & Eastern Traction Company was represented in the week's financing with a $425,000 issue of collateral five-year gold notes.

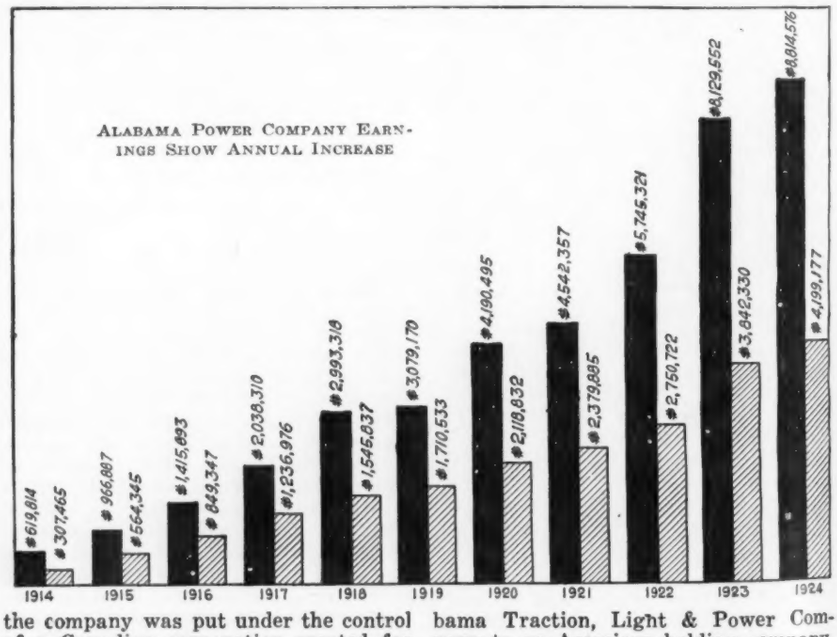
Alabama Power Company's New Parent

How the Alabama Traction, Light & Power Company, a Holding Utility Incorporated in Canada, Will Change Its Capital Structure

BY PAUL WILLARD GARRETT

YEARS ago, when the citizens of Gadsden, Ala., organized the Alabama Power Company, neither the local capitalists nor the American bankers caught the vision that fired the imaginations of the builders. The Alabama Power Company was unable to finance itself properly. Finally, in 1912, London interests saw what the situation promised and agreed to lend money. To facilitate the sale of bonds to Britons the company was put under the control of a Canadian corporation created for the purpose and called the Alabama Traction, Light & Power Company. Thus it is that the power company so styled, a foreign organization, owns all of the common shares of the Alabama Power Company. Three-quarters of the common stock of the holding company itself is held to-day by citizens of the United States, however, and the directors want to throw off the company's foreign affiliation.

The directors have drawn up an ingenious plan, to be voted upon by the stockholders at a meeting in Montreal on October 10, whereby the control of the Alabama Power Company and other properties will pass from the Alabama Traction, Light & Power Company to an American holding company. The Southeastern Power & Light Company, recently incorporated in Maine, will be the new holding company. The change will bring some technical advantages, but there are reasons which lie deeper. So powerful has the or-



Stock and Bond Quotations of Electric Light and Power and Manufacturing Companies

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par value of stocks is $100.)

Companies	Bid Price Saturday, Sept. 13	Low 1924	High 1924
PREFERRED STOCKS			
Operating Companies			
Adirondack Power & Light 7 per cent	97	94	97¾
Appalachian Power, 7 per cent	89	85½	90
Arkansas Light & Power 7 per cent	90	81	93
Asheville Power & Light 7 per cent	96	96	99
Carolina Power & Light 7 per cent	98	95½	100
Central Illinois Public Service 6 per cent	84	84	87
Colorado Power 7 per cent	93	90	97
Connecticut Light & Power 7 per cent	99	99	102
Consumers' Power 6 per cent	90	85	93
Dayton Power & Light 6 per cent	84	84	90
Duquesne Light 7 per cent	107	103½	107½
Eastern Texas Electric 6 per cent	95	81	95
Empire District Electric 6 per cent	73	70	78
Fort Worth Power & Light 7 per cent	97	97	100
Great Western Power 7 per cent	98	96	98
Illinois Northern Utilities 6 per cent	82	82	87
Illinois Power & Light 7 per cent	92½	84	95
Kansas Gas & Electric 7 per cent	93	92	97
Long Island Lighting 7 per cent	98	95	98
Minnesota Power & Light 6 per cent	88	78	88
Mississippi River Power 6 per cent	87	80	90
Nebraska Power 7 per cent	96	89	99
Niagara Falls Power 7 per cent—25	a 29	27	29
Niagara, Lockport & Ont. Power 7 per cent	101	99½	104½
Northern States Power 7 per cent	94	91	97
Ohio Public Service 7 per cent	92	86	94½
Pacific Gas & Electric 6 per cent	90	85½	92½
Penn-Ohio Power & Light 7 per cent	91	84	96½
Pennsylvania Power & Light $7—no par	98	93	99
Penn. Public Service 7 per cent	90	90	100
‡Philadelphia Electric 8 per cent—25	a 38½	29½	39⅜
Southern California Edison 8 per cent	115	112	119
Tennessee Electric Power, 6 per cent	78	71	81
Texas Power & Light 7 per cent	96	95	96½
Utah Power & Light 7 per cent	96	94	96½
Western States Gas & Electric 7 per cent	80	78	85
Yadkin River Power, 7 per cent	97	94	97
Holding Companies			
American Gas & Electric 6 per cent—50	43¾	41½	46
American Light & Traction	92	91	94½
American Power & Light 6 per cent	89½	84	91
American Public Service 7 per cent	80	84	92
American Public Utilities 7 per cent	84	73	87
American Water Works & Electric 6 per cent	87	66	99
Carolina Power & Light 7 per cent	99	95½	99
Central Indiana Power 7 per cent	84	80	90
Cities Service 6 per cent	74	67	75
Commonwealth Power	a 75	72	82
Consolidated Gas 6 per cent—50	58	51	59½
Continental Gas & Electric 7 per cent	83	69	90
Electric Bond & Share 6 per cent	100½	96½	103
General Gas & Electric—$8—no par	103	96	103½
Middle West Utilities 6 per cent	88	80	90
National Power & Light—$7—no par	93½	84	96½
North American 6 per cent—50	a 47¾	43¾	50¾
Northern Ohio Electric	a 23	16	34
Public Service Corp. of N. J. 7 per cent	a 100¾	96½	100½
Public Service Corp. of N. J. 8 per cent	108½	99½	108½
Standard Gas & Electric 8 per cent—50	48¼	46¾	49½
‡United Gas Improvement—50	57	55½	58
United Light & Power—$6.50—no par	79	75¼	80
COMMON STOCKS			
Operating Companies			
Adirondack Power & Light—50	32½	22½	34
Appalachian Power—no par	74½	66½	93
Arkansas Light & Power	60	22	63
Brooklyn Edison	a 115¾	107½	117½
Buffalo General Electric	149	118	155
Carolina Power & Light	238	82½	245
Colorado Power	33	21	35
Commonwealth Edison	132	126	135
§Consolidated Gas, Electric Light & Power	a 135½	113	135½
Dayton Power & Light	133	70	133
Detroit Edison	a 109¾	102½	110½
|| Edison Electric Illuminating of Boston	a 181	163½	190
*Kentucky Hydro-Electric	85¾	84	87½
Long Island Lighting	175	100	195
Mississippi River Power	31	18½	32½
Montana Power	a 64½	61½	71
Niagara Falls Power—no par	a 42½	42½	47
Niagara, Lockport & Ontario Power—no par	53	45	59
Northern Ohio Electric—no par	9	5	16
Northern States Power	103	92	106
North Texas Electric	61	58	84
Pacific Gas & Electric	96	90½	96½
‡Penn Central Light & Power—no par	59½	57	60
Pennsylvania Water & Power	107	98½	110
‡Philadelphia Electric—25	a 38¾	29¾	39⅜
Public Service Co. of Northern Illinois	97	97	104
Puget Sound Power & Light	57	43½	61½
Southern California Edison	98	95	106
Tampa Electric	a 162	134	162
Tennessee Electric Power—no par	39	20	41¼
Virginia Power	63	16	70
Virginia Railway & Power	a 68¾	36	72½
West Penn. Co.	a 85	47½	98

Companies	Bid Price Saturday, Sept. 13	Low 1924	High 1924
Holding Companies			
‡American Electric Power—50	62	22½	62½
American Gas & Electric—no par	85½	43½	86
American Light & Traction	123	115	140½
American Power & Light (old)	390	220	408
American Power & Light (new)	39¼	34½	41½
American Public Utilities	84	35	97
American Water Works & Electric	a 113½	40	120
Carolina Power & Light—no par	230	103	240
Cities Service	143	140	155
Columbia Gas & Electric—no par	a 43¾	33	44½
Commonwealth Power Corp.—no par	105	56	108
Consolidated Gas—no par	a 71½	60¾	72⅝
Continental Gas & Electric	67	49	72
Federal Light and Traction	a 77	75	84
General Gas & Electric	56	22	58
Lehigh Power Securities—no par	80½	31	81½
Middle West Utilities—no par	67	41	69
National Power & Light—no par	180	60	190
Philadelphia Co.—50	47¾	42¾	53½
Power Securities—no par	12½	4	14
Public Service Corp. of N. J.—no par	a 58½	39	59¾
Standard Gas & Electric—no par	a 36¾	31½	37⅜
United Gas & Electric (Conn.)—no par	32½	14	42
Utah Securities	a 33½	16½	37
BONDS			
Operating Companies			
Adirondack Power & Light	6s 1950	102¼	97½ 103
Alabama Power	5s 1946	95	90½ 96
Appalachian Power	5s 1941	94	89 94½
Brooklyn Edison	5s 1949	a 100½	97½ 102½
	6s 1930	a 105	102½ 106
	7s 1940	a 109½	107 110½
Central Indiana Power	6s 1947	193½	88 95
Cleveland Electric Illuminating	5s 1939	100	98½ 100½
Commonwealth Edison	5s 1943	99½	95 100
	5s 1953	98	92 99½
§Consol. Gas, Elec. Lt. & Pwr.	4½s 1935	a 95½	90½ 95½
	6s 1949	104½	101½ 105
	6½s 1951	108½	107 108½
Consumers' Power	5s 1936	98½	94¼ 99½
	5s 1952	90	87 92½
Detroit Edison	5s 1933	a 100½	99½ 100½
Duquesne Light	6s 1949	a 105½	103½ 106½
Great Western Power	5s 1946	95	90½ 96
Kansas City Power & Light	5s 1952	a 93½	89 95½
Mississippi River Power	5s 1951	96½	92 97
Montana Power	5s 1943	a 97¼	95 98
New England Power	5s 1951	98½	97 100
New York Edison	6½s 1941	a 112½	109¼ 112½
Niagara Falls Power	6s 1950	105	104 105½
Northern States Power	5s 1941	a 93¾	89½ 94
	6s 1941	a 104½	101 104½
Ohio Power	7s 1951	106	103 106½
Pacific Gas & Electric	5s 1942	a 93	90¾ 95
Pennsylvania Water & Power	5s 1940	99	96 99½
‡Philadelphia Electric	5s 1966	a 101¾	97 103½
	5½s 1947	a 103¾	99½ 103¾
	6s 1941	a 102½	102½ 107½
Portland Electric Power	6s 1947	a 93¾	89¾ 95¾
Southern California Edison	5s 1939	98½	96 99
	6s 1944	102½	100 103¾
Tennessee Electric Power	6s 1947	a 97¾	93½ 98½
Texas Power & Light	5s 1937	95	91½ 95
Toledo Edison	7s 1941	a 108½	106 109
Utah Power & Light	5s 1944	a 91½	87½ 93½
Holding Companies			
Alabama Traction, Light & Power	5s 1962	82	65½ 83
American Gas & Electric	6s 2014	95½	94 95⅝
American Power & Light	6s 2016	94½	91 94½
Amer. Water Works & Electric	5s 1934	a 92	84½ 94
Commonwealth Power	6s 1947	a 96¾	87 96½
Consolidated Cities Lt., Pwr. & Tr.	5s 1962	74	64 75
Illinois Power & Light	6s 1953	99	95 100½
United Light & Railways	5s 1932	92	87½ 93½
	6s 1952	95½	92 96

ELECTRICAL MANUFACTURING COMPANIES

Companies	Bid Price Saturday, Sept. 13	Low 1924	High 1924
PREFERRED STOCKS			
Allis-Chalmers Manufacturing	a 100½	90	100½
*National Carbon	122	112	125
Worthington Pump & Machinery (A)	a 79½	68	79¾
COMMON STOCKS			
Allis-Chalmers Manufacturing	a 60½	41¾	66½
American Bosch Magneto—no par	a 26½	22½	38¾
Electric Storage Battery—no par	57½	50¼	64
General Electric	a 258¼	193½	281
General Electric—10	a 11½	10¾	11½
*Hurley Machine—no par	a 64	48	64½
†Wagner Electric	23½	20	34¾
Westinghouse Electric & Manufacturing—50	a 62¾	55½	65
Worthington Pump & Machinery	a 29½	23½	31¾
BONDS			
Canada General Electric	6s 1942	a 106½	102¾ 106¾
General Electric	3½s 1942	83	80 83¾
	5s 1952	a 104½	100 105
Robbins & Myers	7s 1952	81	75½ 91½
†Wagner Electric Manufacturing	7s	100¾	97 100¾
Western Electric	5s 1944	a 98½	96 98¾
Westinghouse Electric & Mfg.	7s 1931	a 108½	106¾ 109¾

*Chicago Stock Exchange. †St. Louis Stock Exchange. ‡Philadelphia Stock Exchange. || Boston Stock Exchange. § Baltimore Stock Exchange.
a Bid price Wednesday, September 17.

ganization become that there is, of course, no longer any difficulty in selling securities of the operating company (the Alabama Power), but the directors now are laying plans for the sale on advantageous terms of the holding company's securities as well. It is a step designed to preserve a good balance in the whole capital structure of the organization during the course of future years, and the directors know that American investors will take more interest in the new holding company than they would in a foreign one.

To put the new arrangement into effect, the newly created Southeastern Power & Light Company, which has an authorized capital of 100,000 shares of preferred stock and 500,000 shares of common stock, both without par value, will purchase all of the properties and assets of the Alabama Traction, Light & Power Company. The consideration for the sale will be as follows: (1) The new company will issue 14,375 of its authorized 100,000 shares of preferred stock and 340,000 of its authorized 500,000 shares of common stock. (2) The new company will assume all of the obligations of the Alabama Traction, Light & Power Company, including the payment of principal and interest on bonds. (3) It will pay an amount in cash sufficient to cover the old company's preferred dividends from July 1, 1924, to October 1, 1924, the date when the new Southeastern Power & Light preferred stock becomes cumulative. (4) The new company will assume all expenses in connection with securing the approval of the plan.

On an examination of the amounts of preferred and common stocks of the Alabama Traction, Light & Power Company now outstanding it becomes clear just what the plan involves for present stockholders. In a word, it simply means that for every share of Alabama Traction, Light & Power Company's 6 per cent preferred stock held the investor will receive $1.50 in cash and one share of the Southeastern Power & Light Company's 7 per cent cumulative preferred stock. For every share of common stock held the investor will receive two shares of Southeastern Power & Light Company's common.

Plowing Earnings Back Into Plant

Immense sums have been turned back into the Alabama Power properties to enlarge their services and raise their ultimate earning power. No less than $47,000,000 has been spent upon the properties during the last ten years. The time appears to be drawing nearer when the company should benefit more and more from its far-sighted policies. The increasing popularity of the company's bonds and preferred shares, not to mention a rise from 25 earlier in 1924 to 65 at present in the market price of the common stock, is not, however, something that results altogether from great promises for the future. An extraordinary and persistent growth already has come in earnings. Gains have been shown every year for the last decade or so both in gross and net earnings. Gross has risen steadily from $620,000 in 1914 to $8,815,000 for the twelve months ended July 31, 1924. Net earnings in the same period have risen from $307,000 to $4,199,000.

Local Sales of Stock

Customers of Thirteen New England Central Stations Own More than 150,000 Shares

CUSTOMER ownership is growing rapidly in New England despite the handicap of laws on the Massachusetts statute books which it is hoped to overcome in the near future. Central-station companies are getting interested in the subject, and while progress has been conservative as regards the number of companies taking part in this movement, more than 150,000 shares of stock have been sold to customers by thirteen companies reporting to F. L. Hall, chairman of the committee on customer ownership of the New England Division of the National Electric Light Association. To the beginning of 1924 the Central Maine Power Company had sold 63,573 shares of stock to 10,370 customers, and 18 per cent of the customers are shareholders. The Danbury & Bethel (Conn.) Gas & Electric Company had sold 18.9 per cent of its customers 13,410 shares. Last year only thirteen New England companies made special effort to sell stock to customers, but interest is growing steadily.

RESULTS OF CUSTOMER OWNERSHIP CAMPAIGNS IN NEW ENGLAND

Company	Campaign Date	No. Shares Sold to Dec. 31, 1923	No. Shareholders Obtained	No. of Customers	Percentage of Customer Ownership Shareholders
Bangor Railway & Electric	1921	5,399	1,319	16,000	8.1
Central Maine Power	1908	63,573	10,370	57,500	18.0
Danbury & Bethel Gas & Electric Light	1920	13,410	1,177	6,200	18.9
Eastern Connecticut Power	1923	400	75	10,000	0.75
Greenfield Electric Light & Power	1916	20,149	234	8,256	2.7
Hartford Electric Light	1923	1,529	617	48,000	1.3
Keene Gas & Electric Light	1922	1,500	75	5,675	1.3
Narragansett Electric Light	1918	26,050	5,907	71,554	8.3
Newport Electric	1922	1,740	512	5,500	9.3
Northern Connecticut Light & Power	1921	660	187	5,500	3.4
Pittsfield Electric	1921	1,279	170	8,440	2.0
Rockville-Willimantic Lighting	1922	903	306	8,358	3.7
Springfield Light, Heat & Power	1921	2,168	538	13,000	4.1

The Edison Electric Illuminating Company of Boston is making a thorough study of the problem, and this year the Narragansett Electric Lighting Company, Providence, R. I., sold 7,302 shares, gaining 1,834 new stockholders The Hartford (Conn.) Electric Light Company is undertaking to sell $250,000 in preferred stock to customers, the rights having been waived by their owners at the request of the board of directors. Recently the Northern Connecticut Light & Power Company sold $100,000 in 7 per cent preferred stock in three weeks by advertising and circularizing.

The Greenfield (Mass.) Electric Light & Power Company has sold a total of 20,149 shares to customers and in a recent campaign sold 6 per cent preferred stock at $25 par to persons in forty-three different occupations. Public relations have been improved and much voluntary co-operation from customers in outlying towns has been enjoyed in connection with reports on the state of public sentiment and suggestions for bettering conditions.

Dividends Declared

The following quarterly dividends were announced by central-station companies and electrical manufacturing companies during the seven-day period ended September 16:

Name of Company	Per Cent	When Payable
American & Foreign Power, Inc., pf	$1.75	Oct. 1
American Gas & Electric, pf	1¼	Nov. 1
American Gas & Electric, com	25c.	Oct. 1
American Power & Light, pf	1¾	Oct. 1
Arizona Power, 7% pf	1¾	Oct. 1
Central States Electric, pf	1¾	Oct. 1
Columbus Electric & Power, com.	2½	Oct 1
Columbus Electric & Power, 1st and 2d pf	1¾	Oct. 1
Commonwealth Power, pf	$1.50	Nov. 1
Commonwealth Power, com	$1.00	Nov. 1
Continental Gas & Electric, com.	75c. *	Oct. 1
Continental Gas & Electric, pf	$1.50	Oct. 1
Continental Gas & Elec., prior pf.	$1.75	Oct. 1
Continental Gas & Elec., partic pf.	$1.50†	Oct. 1
Consumers Electric Lt. & Pwr., pf.	1¾	Sept. 30
Detroit Edison	$2	Oct. 15
Electric Light & Power Co. of Abington & Rockland	2	Oct. 1
Kentucky Hydro-Electric, pf	1¾	Sept. 20
Kentucky Securities, com	1¼	Oct. 1
Kentucky Securities, pf	1¾	Oct. 15
Metropolitan Edison, pf	$1.75	Oct. 1
Monongahela-West Penn Public Service, 6% pf	37½	Oct. 1
Monongahela-West Penn Public Service, 7% pf	43¾	Oct. 1
Narragansett Electric Lighting	$1	Oct. 1
Nevada-California Electric, pf	$1.75	Nov. 1
North American Light & Power, pf.	1¾	Oct. 1
Ottawa Power, pf	1¾	Sept. 30
Ottawa Power, com	1¼	Sept. 30
Pennsylvania Edison, pf	$2	Oct. 1
Public Service Co. of Oklahoma, com	2	Sept. 30
Public Service Co. of Oklahoma, prior lien	1¾	Sept. 30
Public Service Co. of Oklahoma pf.	1¾	Sept. 30
United Gas Improvement, com	62½c.	Oct. 15
United Gas Improvement, pf	62½c.	Dec. 15
Utah Power & Light, pf	1¾	Oct. 1
West Penn Power, 7% pf	1¾	Nov. 1
Electric Controller & Mfg., com.	$1.25	Oct. 24
Electric Controller & Mfg., pf	1¾	Oct. 24
Electric Storage Battery, com	$1	Oct. 1
Electric Storage Battery, pf	$1	Oct. 1
Yale & Towne Manufacturing, extra	$1	Oct. 1
Yale & Towne Manufacturing, reg.	$1	Oct. 1

* And 0.75 per cent extra in common stock.
† And 25 cents extra in cash and 0.25 per cent extra in common stock.

Company Reports

Among the company reports issued during the past week for the month of July are the following:

Name of Company	Gross Revenue for July, 1924	Gross Revenue for July, 1923
Adirondack Power & Light*	$561,499	$531,981
American Water Works & Electric and subsidiaries	2,940,528	3,005,916
Columbia Gas & Electric and subsidiaries	1,433,997	1,430,051
Detroit Edison	2,345,019	2,367,629
Havana Electric Railway, Light & Power	1,189,584	1,095,800
Jamaica Public Service	49,026	44,213
Manila Electric*	308,037	295,778
Mississippi Power & Light	106,992	92,284
New England Power System	491,245	619,069
Utah Securities*	906,078	855,435
West Penn	1,897,053	1,973,334
American Telephone & Telegraph	6,151,105	5,773,952

*August

Collyer Plans Stock Increase.—Stockholders of the Collyer Insulated Wire Company, Pawtucket, R. I., have voted to increase the company's capital stock from $500,000 to $1,000,000. Of the new stock 2,500 shares will be offered at par ($100) to stockholders at the rate of one share for every two now held.

Business Conditions

BUSINESS is on the upward grade and is expected to remain that way at least until after the election. The sentiment of electrical men is that if Davis or Coolidge is elected business will continue to move right ahead. On the other hand, should the election be thrown into the House of Representatives and a possibility of C. W. Bryan becoming President arise, an upward business trend would be questionable.

General supply, industrial and merchandise lines are showing a good increase in sales—in fact, better than for the same period last year, despite the poor fan season. Manufacturers report that orders are being received from all over the country except from around Minneapolis and St. Paul and also southern California. New England has been showing steady improvement in the face of the textile situation. Inquiries have been increasing very materially and orders are following in good proportion.

Central-station companies, contractor-dealers and jobbers have all been contributing toward good business, but buying is still mostly on a hand-to-mouth basis and there is danger of a shortage of stock. With this in view several manufacturers are building up unusually large stocks so as to be ready to answer the calls of the trade.

In New England contractor-dealers are purchasing actively and a large volume of appliances is being sold. The railroads have been actively in the market for pole-line hardware in the New York district during the last ten days, and an increased activity is still being noticed by jobbers, with no lethargy in the market. In the Southeast activity continues with a general, though not marked improvement, Florida being the most active section. Brisk buying in the Middle West is stimulating trade and a good volume of business is being transacted. On the Pacific Coast business is quiet in some sections and better in others.

Radio Credit Committee Formed by Manufacturers' Association

THE first comprehensive system for the interchange of credit information within the radio industry has just been installed in the central office of the Radio Manufacturers' Association at 123 West Madison Street, Chicago, under the direction of the association's credit committee. This committee is composed of Walter H. Trimm, chairman; Donald MacGregor, Theodore Sheldon, Ronald Webster, John C. Tully and H. E. Wilkins.

The committee in its report to the association which resulted in the installation of the system said: "We are in a new business—a business growing faster than any other industry in the country. It is not strange, then, that we need a source of credit information not heretofore provided. Our business is not confined to one class of merchants. We reach the radio jobber, the electrical jobber, the hardware jobber, the automotive jobber, the music trade jobber and others. For our own protection we must have available all the credit information we can secure regarding all of our customers, no matter what their business may be outside of radio lines, and your committee believes that the only way to secure this protection is to interchange credit information among ourselves." The committee will actively direct the work of the credit bureau and further states that "the plan will be elaborated from time to time just as fast and as much as the enlarging membership of the association requires."

Non-Ferrous Metal Market Weak —Copper and Tin Lose Ground

COPPER and tin prices have been falling almost daily as a result of a decline in the London price of both metals. Zinc has also been easier, but lead remains strong, although sales have been light. Only moderate sales of copper have been reported during the week, despite the fact that consumers have been very much interested in the market. Six of the largest manufacturers, chiefly wire and brass companies, have been following prices closely. Some heavy purchases are expected at the present level. Foreign sales, especially to Germany, were very good.

NEW YORK METAL MARKET PRICES

	Sept. 10, 1924 Cents per Pound	Sept. 17, 1924 Cents per Pound
Copper, electrolytic	13¼–13⅜	13 –13¼
Lead, Am. S. & R. price	8	8
Antimony	10¾–11	11⅛
Nickel, ingot	27½–28½	27½
Zinc, spot	6⅛	6.15
Tin, Straits	51	47½
Aluminum, 98 to 99 per cent	28	28

The official contract price of the American Smelting & Refining Company for lead remains at 8 cents. The demand for the metal has been fair with no pressure to sell. The market appears hesitant, with October lead still available in good-sized quantities.

Zinc sales were made to galvanizers, who have been moderately interested in the market, only after a decided shading in prices. A small tonnage was sold abroad. The tin market took another drop during the week as a result of the withdrawal of speculative support on the London market. At the low price of 47 cents per pound buying was unusually heavy.

Activity in the Southeast Continues with a General Improvement

ACTIVITY in the Southeast appears to have definitely replaced the summer dullness, and all districts give indications of a general, though not too marked, improvement in business. Florida is undoubtedly the most active section with much building construction under way. Forida central stations are also busily engaged in making extensions and additions to their distribution lines as well as adding to their generating capacity. The result is an excellent volume of sales of wiring devices, electrical building material and line material.

Electrical retailers are anticipating a very satisfactory fall and holiday business, while jobbers and manufacturers report generally encouraging conditions, one jobber booking the largest volume of business during August since the World War. The steel industry in and around Birmingham is in a more optimistic frame of mind than for some time past, though as a rule the large plants still run on about a 60 per cent basis. One new large furnace was recently put into operation. The coal industry, however, continues somewhat quiet, although the fall is expected to usher in more satisfactory conditions. Textile mills generally are returning gradually to a more normal status, the prospect of cotton selling around 20 cents being an encouraging factor.

New England Contractor-Dealers Buying More Actively

INCREASED sales of wiring supplies to contractors were the feature of the New England electrical market at the beginning of this week, owing to the early fall improvement in the building industry. Dealers are also retailing larger volumes of appliances, vacuum cleaners, radiators, flatirons and portable lamps showing the greatest activity. Sales of ranges are holding up well and household refrigerating units are moving better, although the total volume is below figures anticipated later this fall. Meter and transformer sales are increasing, and radio apparatus is in very good demand.

Central-station buying is still substantial. However, poles and crossarms have fallen off in demand as seasonal requirements are more and more completed. The number of central-station employees is close to the maximum for this year, but in some localities restrictions upon opening highways will soon curtail winter construction work and lead to a falling off in total payrolls. General conditions in this district are slowly improving, but collections are spotty and there is little evidence of inflation. Labor is restive in the textile industry.

No Lethargy in the New York District—Sales Increase

DURING the last ten days there has been much activity in the New York district on pole-line hardware, chiefly from the railroads, though some business has been obtained from central-station companies. Utilities have not been actively purchasing much material except in one or two instances where new projects are under way, but plenty of additional work is being contemplated and manufacturers are receiving inquiries for prices on the necessary equipment. A fair business is being transacted in distribution and small power transformers. Industrial

buying is very good in some cases and slow in others, and it can best be classed as spotty.

Increased activity is still being noted by the jobbers, better conditions being evident in all lines. Radio, of course, has shown a very large improvement. Manufacturers and jobbers who are briskly seeking business find that there is no lethargy in the market. Many small stock orders have been received within the last two or three weeks. This is indicative of a demand which is being felt by jobbers and dealers, and apparently the field is waking up to this situation.

Brisk Buying in the Middle West Stimulates Trade

EVERY indication points to better electrical business for the fall months in the Middle West. Central-station maintenance purchases have increased materially this week and purchases are being made for longer periods. Considerable line extension work is again under way, and sizable orders for meters and transformers were placed this week. The demand for motors is getting better. Several 100-hp. motor-generator sets were sold, and the outlook is promising, with several large installations in view.

The jobbing trade also reports a satisfactory week. The number of inquiries has increased and the turnover in general business remains very good. One of the larger hotels is requesting estimates on an addition to the present building which will require a large amount of wire and conduit, and one of the Chicago parks is accepting proposals for a large park-lighting project. Prices remain practically the same, with a few readjustments here and there. Loom prices, which have been firm for the last four or five months, took a decided drop this week. A wrangle between manufacturers resulted in a reduction of about 19 per cent. Building activities continue, and should the weather remain moderate, a good amount of business will be derived from this source during the next two months.

Business Quiet in Some Districts on the Pacific Coast

BUSINESS has been rather quiet in the southwestern district of the Pacific Coast in comparison with the first two weeks of the month, when many good stock orders and a general improvement in purchasing were noted. The improvement in the lumber situation in the Northwest has resulted in a better demand for motors and generating equipment, and industrial and residence lighting material has moved in very good volume, with jobbers confidently predicting still better sales during the next two months. Domestic appliances, particularly ranges, washing machines and irons, are showing a healthy movement, which also is expected to be prolonged well into the winter. Inquiries are increasing on farm-lighting plants and some orders are materializing, but still better business is expected after the harvest. Stocks, with the exception of radio supplies, are very good, but prices are holding firm.

In the southwestern section of the Coast industrial and railroad business is falling off more than business from dealers and contractors. It is felt that perhaps the political uncertainty is playing a part in this result. Prices are again softening, decreases being made in non-metallic flexible conduit, conduit boxes and fiber conduit. Radio accessories and hollow ware seem to furnish the bulk of the present sales of dealers in this region.

Activities of the Trade

A Directory Service for the Radio Industry

In three short years the radio industry has grown so rapidly that today it includes more than 3,000 manufacturers, nearly a thousand jobbers and manufacturers' agents, many thousand retailers and some five hundred broadcasting stations. From annual sales of $5,000,000 in 1920, its output in receiving apparatus alone has increased to estimated sales of $300,000,000 in 1924. Naturally an industry of such size needs buying and selling information, particularly because it is so new; but this very newness has made it difficult to get complete and accurate data.

To give the radio buyer and seller the answers to all their vital questions, the McGraw-Hill Company announces the "Radio Trade Directory" and the "Directory's List Service." As the world's largest publisher of engineering, industrial and business publications, including such magazines as the ELECTRICAL WORLD, *Electrical Merchandising, Electrical Retailing, Journal of Electricity* and eleven others, the company has exceptional facilities to compile and publish such a directory.

In the directory, which will be issued in November and quarterly thereafter, will be found classified lists of all the American manufacturers of everything used in the construction, operation and maintenance of radio equipment, both transmitting and receiving—makers of raw and semi-finished materials, parts, accessories, supplies and machinery and tools peculiar to the industry. The "List Service" will provide authentic data on the wholesalers of the country as well as complete lists of the radio retail trade. The work of compiling the directory and the list service is in charge of J. S. Cortelyou, formerly editor and business manager of the "Automobile Trade Directory," assisted by a trained staff.

Birtman Electric Company Building New Home

The Birtman Electric Company, 640 Lake Street, Chicago, has acquired more than 81,000 sq.ft. of ground in the Healy Industrial District, Chicago, just west of the Lyon & Healy plant on Fullerton Avenue, for $57,000. The property is served by the Chicago, Milwaukee & St. Paul Railway. A three-story plant and several one-story buildings will be erected, including an administration building and a machine shop.

Construction work on the first unit of the plant, which will cost $300,000, is now progressing rapidly since the company, according to President Butz, desires to be in its new quarters by January 1. The company manufactures the "Magnetic" and "Bee Vac," vacuum cleaners and other electrical specialties.

Westinghouse Receives $500,000 Steel-Mill Contract

The Westinghouse Electric & Manufacturing Company has been awarded a contract by the Bethlehem Steel Corporation for electrical equipment for the 55-in. and 28-in. structural-steel mill at the Lackawanna (N. Y.) plant. The electrical equipment will cost more than $500,000. This is the sixth order for electrification of plants that has been placed with the Westinghouse company by the Bethlehem Steel Company since 1924.

The Belden Manufacturing Company, 2300 Southwestern Avenue, Chicago, has issued a new price list of the cord and specialties department, effective since September 1; also a new price list of lamp cord and rubber-covered wire, effective since September 2.

The Pelton Water Wheel Company of San Francisco has received an order for three horizontal impulse turbines of 1,950 hp. each to be installed in the Kehaka plant of the Hawaiian Commercial Sugar Company of Maui, T. H The power to be developed will largely be used for irrigation pumping.

The Strand & Sweet Manufacturing Company, Winsted, Conn., manufacturer of "Sweetstrand" enamel wire, announces that it will be established in its new factory on October 1. This will permit the company to increase its capacity by 50 per cent to take care of orders already booked. The company states that at present its output for enamel wire is taken up to March, 1925.

The American Electric Switch Company, Minerva, Ohio, manufacturer of electric switches, announces that the general offices have been moved from Canton, Ohio, to Minerva, Ohio, and that several new items have been added to its line of manufacture in the way of entrance switches.

The Pittsburgh Lamp, Brass & Glass Company, Pittsburgh, has appointed John W. Vose, for the past six years purchasing agent of the Foster McDonald Company, Boston, as New England representative, with headquarters at 12 Pearl Street, Boston. Mr. Vose will cover all the New England States except Connecticut.

New Trade Literature

MULTIPLE CHART METER.—Bulletin No. 624 issued by the Esterline-Angus Company, Indianapolis, contains an article describing the use of the "Esterline-Angus" multiple-chart speed meters in central-station operation.

INSULATORS.—A folder has been issued by the R. Thomas & Sons Company, East Liverpool, Ohio, entitled the "Missing Link," which describes and illustrates the link-type insulator hardware made by this firm. Twelve reasons are submitted why efficient operating service can be assured.

ELECTRIC CONTROL EQUIPMENT.—The Electric Control Limited, 177 Reid Street, Bridgeton, Glasgow, Scotland, is distributing two leaflets, one entitled "'Empire' Automatic Control" and the other "'Empire' High-Tension Line Equipment up to 132,000 Volts," dealing with its exhibits at the British Empire Exhibition.

DIRECT-CURRENT TRANSFORMER.—The Gisholt Machine Company, Madison, Wis., is distributing bulletin DCT-9, covering the "Gisholt" direct-current transformer.

EXPANSION JOINTS. — Bulletin J-3 issued by the Henry Pratt Company, 2,222 South Halsted Street, Chicago, describes the "Phillips" expansion joint, a flexible connection for use between a steam-turbine exhaust flange and its condenser.

STEAM CONDENSERS.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued a booklet, known as circular No. 1,662, on steam condensers of the surface, low-level jet and barometric types and auxiliary equipment, including air removal apparatus, pump drives, motors and control equipment.

POLYPHASE TRANSFORMERS. — Bulletin No. 2,034 issued by the Pittsburgh Transformer Company, Pittsburgh, describes some of the "Pittsburgh" 10,000-kva. self-cooled, polyphase transformers. It also calls attention to the new "Pittsburgh" radiator.

PORTABLE FLIGHT CONVEYOR. — Bulletin No. 24a issued by the Gifford-Wood Company, Hudson, N. Y., covers its latest portable flight conveyor for handling bituminous coal and other loose and lumpy materials.

ELECTRICAL MEASURING INSTRUMENTS.—The Leeds & Northrup Company, 4,901 Stenton Avenue, Philadelphia, has issued a new edition of catalog No. 48, covering its apparatus for measuring conductivity of electrolytes. Apparatus for the research laboratory and the general laboratory for industrial process control and for instructional purposes is described in this publication. A brief outline of the method for determining conductivity of electrolytes, with a statement of refinements necessary for the precision of measurement, is given in the appendix.

TRANSFORMERS. — The American Transformer Company, 178 Emmet Street, Newark, N. J., has issued the first number of a series of bulletins it intends to publish on the uses and types of transformers. This bulletin (No. 1,020) contains an article on 220-110-volt, single-phase auto-transformers or balancing coils for 110-volt, three-wire distribution.

WIRE-SAG CHARTS.—The Copper Weld Steel Company, Braddock post office, Rankin, Pa., has issued a sixteen-page pamphlet containing sag and tension charts for its wire and standard copper weld. It also includes loading charts of wires ranging from No. 0 to 10, solid and stranded.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Where the item is numbered, further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number.

Purchase is desired in China (No. 11,687) for electrical fixtures and equipment.

Purchase is desired in Spain (No. 11,677) for electric cranes for wharves.

An agency and purchase is desired in Poland (No. 11,678) for radio apparatus and parts.

Purchase is desired in Switzerland (No. 11,676) for radio apparatus and parts.

DEMAND FOR ELECTRICAL APPARATUS IN MARANHAO, BRAZIL.—The installation of new electric light and power, water, sewerage and street-car systems in the State of Maranhão, Brazil, is nearing completion, and all classes of material and appliances for these services, it is stated, will be required. W. T. MacCaskey, administrator, Service de Luz Electrica, São Luiz, Maranhão, Brazil, would like to receive catalogs and net prices on electric and water meters, sanitary fixtures and other appliances.

Construction News

Projects, Plans, Bids and Contracts, Contemplated or Under Way

Middle Atlantic States

FREDONIA, N. Y.—The Village Board of Trustees is considering extensions to the street-lighting system, including additional ornamental lamps.

LEE CENTER, N. Y.—Surveys are being made by the Northern New York Utilities, Inc., for the erection of a transmission line from Rome to Lee Center to furnish electricity here.

REDFIELD, N. Y.—The Niagara, Lockport & Ontario Power Company Buffalo, has applied to the Public Service Commission for permission to erect a transmission line and distribution system to supply electricity in Redfield under the terms of a franchise granted by the Town Board.

RIVERHEAD, N. Y.—The Long Island Lighting Company has applied for permission to erect a transmission line from Riverhead to Mattituck.

ROCHESTER, N. Y.—The City Council is considering the installation of a new lighting system on Highland Parkway and extension of the lighting system in Eckert Place.

HOGESTOWN, PA. — The Cumberland Electric Company is being formed by local interests to install and operate a light and power system in this section. A transmission line will be built to Mechanicsburg for power supply. Hogestown has not a post office.

KINGSTON, PA.—Plans, it is reported, are being prepared by the Luzerne County Gas & Electric Company for the construction of a hydro-electric plant next year at Hunlock Creek, to cost with transmission lines, about $6,000,000.

KINGSTON, PA.—The New Columbus, Ross, Huntington and Fairmount Township Electric companies, recently organized, plan to erect transmission lines in the respective districts for which they are named. H. M. Blake, 317 South Smedley Street, Philadelphia, is treasurer of all companies.

MAHANOY CITY, PA.—The Lehigh Valley Coal Company contemplates the installation of electric power equipment in connection with the remodeling and modernizing of the coal breaker at its Centralia mine.

PHILADELPHIA, PA. — The Arguto Oilless Bearing Company, 149 West Berkley Street, has filed plans for the construction of a one-story power house at its plant, for which foundations will be laid at once.

PITTSBURGH, PA.—The D. L. Clark Company, Martindale Street, plans to build a power plant, to cost about $45,000, at North Side. P. Dietz, Lyceum Building, Pittsburgh, is engineer.

POTTSVILLE, PA.—The Haddock Mining Company, operating the Silver Brook coal mines, is reported to be planning for the installation of electric power and mining machinery at recently purchased anthracite-coal properties in the Salem Hill section, to develop an output of about 25,000 tons per month.

RANSOM, PA. — The Scranton Electric Company has preliminary plans in progress for the construction of a local steam-operated electric power plant on the Ohio River, at a cost of more than $500,000. A transmission line will be built.

BALTIMORE, MD. — The Gold Dust Corporation, 111 West Washington Street, Chicago, Ill., plans a power house at its proposed plant in the Canton section. The project will cost approximately $1,000,000.

BALTIMORE, MD. — The General Elevator Company, 2400 South Charles Street, plans for the installation of electric power equipment at its proposed plant at Ridgely, Bush and Russell Streets, for the manufacture of passenger and freight elevators, estimated to cost $80,000. W. S. Austin, Maryland Trust Building, is architect.

HAVRE DE GRACE, MD.—Citizens have voted down the proposed bond issue of $300,000 for the installation of a municipal electric light and power plant, and the project will be held in temporary abeyance by the City Council.

North Central States

DETROIT, MICH.—The Hudson Motor Car Company, East Jefferson Avenue, has plans for the construction of a one-story power house at its plant, 46 ft. x 50 ft., and will soon begin work.

DETROIT, MICH.—The Ford Motor Company plans for the installation of electric power equipment at the proposed addition to its steel mills at River Rouge, Detroit, for which plans have been drawn by Albert Kahn, Marquette Building, architect.

EVARTS, KY.—The R. L. Brown Coal Company, recently organized, is said to be planning for the installation of electric power equipment and mining machinery for the development of a portion of a tract of 500 acres of land acquired from the Standard Harlan Coal Company. R. L. Brown is president.

ATTICA, IND.—The Attica Electric Company has been granted permission to issue bonds for $62,000 and preferred stock for $20,000, the proceeds to be used for extensions and improvements, including the purchase of an existing transmission line from Crawfordsville to Wingate, about 27 miles, heretofore owned by the Montgomery Light & Power Company, for a consideration of $28,818.

ELKHART, IND.—The construction of a new power house at the Central High School, to cost about $80,000, is under consideration by the Board of Education.

INDIANAPOLIS, IND.—The Real Silk Hosiery Company has filed plans for the construction of a one-story power house at its mill. A contract for building superstructure has been let to the Union Iron Works, Indianapolis.

HARVEY, ILL.—The Whiting Corporation, manufacturer of electric traveling cranes, etc., plans for the early construction of a one-story power house, 75 ft. x 75 ft., for which a general building contract has been let to T. D. Hobson & Son, Harvey. It will cost approximately $145,000.

FARIBAULT, MINN.—The City Council is considering the construction of a municipal electric light plant and also a garbage-disposal plant.

PARK RAPIDS, MINN.—The local municipal hydro-electric power plant and distributing system has been acquired by the Minnesota Power & Light Company. Plans are under way for extensions and improvements.

DES MOINES, IOWA—The Kratzer Carriage Company, 100 South West First Street, manufacturer of motor-truck bodies, plans for the installation of electric power equipment in connection with the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at $100,000.

GREENFIELD, IOWA—The Common Council has disposed of a bond issue of $45,000, the proceeds to be used for extensions and improvements in the municipal electric power plant.

PRIMGHAR, IOWA.—The Iowa Light, Heat & Power Company has acquired the local power plant and system of the Primghar Electric Company and plans for extensions and improvements.

PLEASANT HILL, MO.—The West Missouri Power Company has issued bonds for $870,000, a portion of the proceeds to be used for the purchase of the Fort Smith & Nevada Light, Heat & Power Company and the Clinton Coal & Mining Company, including proposed extensions and improvements and additions to transmission system.

Southern States

MATTHEWS, N. C.—The Common Council is arranging a bond issue of $30 000, the the proceeds to be used for a municipal electric lighting plant.

RALEIGH, N. C.—The Carolina Power & Light Company has taken over the property of the Smitherman Power Company, Troy, which served the towns of Biscoe, Candor, Jackson Springs, Ellerbe and Troy, and the Deep River Power & Light Company, which supplies electricity at wholesale in Pittsboro, and in Ramseur and Franklinville from a hydro-electric plant at Locksville. Connections are now being made with the main transmission line of the Carolina company. The municipal electric plants at Pittsboro and Ellerbe, it is stated, will be acquired by the Carolina Power & Light Company.

CONYERS, GA. — Contract has been awarded by the Milstead Manufacturing Company for the construction of a dam in connection with a hydro-electric project on the Yellow River, to cost about $50,000.

WAYCROSS, GA.—The City Council is considering installing electrically operated pumps at the municipal waterworks to replace the present all steam-driven equipment.

BIRMINGHAM, ALA.—The Hardie-Tynes Manufacturing Company, manufacturer of engines and parts, etc., plans for the installation of electric power equipment in connection with the rebuilding of its machine shop, recently destroyed by fire with loss estimated at $700,000, including machinery. W. D. Tynes is president.

GADSDEN, ALA.—The Peoples' Hydro-Electric Power Company has tentative plans for a hydro-electric power plant on the Coosa River near here. Application has been made to the Federal Power Commission for a preliminary permit.

FORT DEPOSIT, ALA.—The Alabama Power Company plans for the construction of a transmission line here. A distributing system will also be installed.

LOCKPORT, LA.—The Orange Ice, Light & Water Company, Orange, Tex., plans for the construction of a transmission line along the Old Spanish Trail to this section.

CACHE, OKLA.—A franchise has been granted to the Cache Telephone & Electric Company to supply electricity here. The company heretofore has been furnishing electricity from a small plant which was inadequate to meet the demands for service. It has entered into a contract with the Southwestern Light & Power Company for energy from its high-tension line, which passes through the town.

DURANT, OKLA.—The installation of an ornamental lighting system, to cost about $15,000, is under consideration. Present plans call for sixty lamp standards.

ROCKY, OKLA.—The Inland Utilities Company has plans under consideration for the construction of a transmission line here, about 8 miles. The company has work in progress on a steam-operated electric power plant at Hobart, Okla., and will furnish service from this point.

CRISP, TEX.—The Crisp Brick Company, Ferris, Tex., recently organized, plans for the installation of motors and other electric power equipment in connection with proposed extensions and improvements at the plant of the Crisp Pressed Brick Company, recently acquired. E. T. Cole is president.

Pacific and Mountain States

WASHOUGAL, WASH.—C. W. Cottrell, Washougal, and associates have made application for permission to use water from the Washougal River for a proposed hydro-electric development.

LOS ANGELES, CAL.—The Los Angeles Gas & Electric Corporation has filed plans for the construction of a two-story substation at 1035 West Twenty-fourth Street, to cost about $25,000.

LOS ANGELES, CAL.—At a special election citizens have approved a bond issue of $16,000,000, the proceeds to be used for the construction of a municipal electric distributing system. The Municipal Power Bureau will be in charge.

LOS ANGELES, CAL.—The White Portland Cement Company, recently organized with a capital of $3,000,000, represented by Lewis Cruickshank, Los Angeles Trust and Savings Building, plans for the construction of a power house in connection with a proposed cement mill on a 15-acre tract of land, near the city, now being acquired. The company is headed by L. V. Bentley and J. C. Rhodes.

ROCHE, CAL.—The Coast Rock & Gravel Company, Fresno, Cal., plans for the installation of electric power equipment at its proposed local rock-crushing plant, estimated to cost $200,000.

Electrical Patents

Announced by U. S. Patent Office

(Issued August 12, 1924)

1,504,294. TELEPHONE SYSTEM; S. B. Williams, Jr., Brooklyn, and E. E. Hinrichsen, New York, N. Y. App. filed Sept. 24, 1920. Private-branch exchange system which may be used in conjunction with either manual or machine-switching central offices.

1,504,295, 1,504,296. TELEPHONE-EXCHANGE SYSTEM; S. B. Williams, Jr., Brooklyn, N. Y. filed Dec. 15, 1920. Mechanical switching.

1,504,297. TELEPHONE-EXCHANGE SYSTEM; S. B. Williams, Jr., Brooklyn, N. Y. App. filed June 20, 1921. Machine switching.

1,504,298. PROCESS OF RUST-PROOFING BY COATING WITH CADMIUM; W. A. Wissler and C. H. Humphries, Kokomo, Ind. App. filed April 9, 1921.

1,504,301. METHOD OF PRODUCING A BALANCED TELEPHONE EXCHANGE; A. H. Adams, Galion, Ohio. App. filed Dec. 27, 1918.

1,504,303. METHOD OF AND MEANS FOR REDUCING STATIC DISTURBANCES; H. A. Affel, Brooklyn, N. Y. App. filed June 3, 1921. In radio transmission.

1,504,304. TELEPHONE-EXCHANGE SYSTEM; W. P. Albert, East Orange, N. J. App. filed Dec. 22, 1920. Where machine-switching apparatus is used for building up talking connections.

1,504,312. SECONDARY STORAGE BATTERY; E. N. Baldwin, Donora, Pa. App. filed Dec. 6, 1922. As used generally in radio transmission and known as B batteries.

1,504,319. TESTING APPARATUS; F. H. Best, Westfield, N. J. App. filed Aug. 9, 1920. For measuring the electrical influence of one transmission circuit on another as telephone lines.

1,504,337. TELEPHONE SYSTEM; H. M. Friendly, Portland, Ore. App. filed May 16, 1921. Applicable to automatic and semi-automatic systems.

1,504,359. ELECTROLYTIC CELL; I. H. Levin, New York, N. Y. App. filed June 12, 1920. With flow of distilled water controlled.

1,504,367. PROCESS OF ELECTRIC WELDING; J. W. Meadowcroft, Philadelphia, Pa. App. filed June 30, 1921. Spot-welding.

1,504,374. COMBINATION HICKEY LOOP; P. J. Pfeifer, Cleveland, Ohio. App. filed Nov. 15, 1922. For lighting fixture.

1,504,381. AUTOMATIC TELEPHONE SYSTEM; R. G. Richardson, Chicago, Ill. App. filed Feb. 4, 1918.

1,504,392. AUTOMOBILE; J. Strauss, New York, N. Y. App. filed March 3, 1920. Auxiliary emergency driving mechanism.

1,504,406. SIGNALING SYSTEM; C. White, East Orange, N. J. App. filed May 5, 1921. Four-wire system where means are provided at an intermediate station for the operator to listen in and to communicate thereover, if desired.

1,504,426. WIRELESS TELEGRAPHY; W. M. Bruce, Jr., Springfield, Ohio. App. filed July 7, 1919. Means for translating the wireless waves so that they can be read from an ordinary sounder or recorder and a record made.

1,504,435. TELEPHONE SYSTEM; H. D. Currier, Chicago, and G. R. Eaton, Oak Park, Ill. App. filed Feb. 28, 1921. Trunking systems for toll-line use.

1,504,438. SHORT-CIRCUITING DEVICE FOR MOTORS; C. P. Eisenhauer, Dayton, Ohio. App. filed Aug. 25, 1921. For single-phase repulsion-induction motors.

1,504,462. TRANSMISSION OF RADIO SIGNALS EMPLOYING UNDAMPED WAVES; R. B. Woolverton, Washington, D. C. App. filed July 25, 1921.

1,504,463. CIRCUIT-CONTINUING DEVICE; H. A. Douglas, Bronson, Mich. App. filed July 21, 1919. As used in a headlight structure for automobiles.

1,504,478. PANELBOARD SUPPORT; G. W. Hyser, Minneapolis, Minn. App. filed April 12, 1921.

1,504,483. RHEOSTAT; P. E. Klopsteg, Chicago, Ill. App. filed May 31, 1922. Sliding contact type.

1,504,535. MULTIPLEX TRANSMISSION CHANNEL; H. A. Affel, Brooklyn, N. Y. App. filed Dec. 31, 1920. Employing carrier currents.

1,504,537. POWER-LIMITING AMPLIFYING DEVICE; H. De F. Arnold, Maplewood, N. J. App. filed Sept. 3, 1915. In radio communication systems.

1,504,542. ELECTRIC DISTRIBUTION SYSTEM; G. A. Cardwell, New York, N. Y. App. filed Aug. 21, 1919. As applicable to printing-telegraph systems, etc.

1,504,551. DYNAMO-ELECTRIC MACHINE; N. R. Haas, Dayton, Ohio. App. filed July 12, 1920. Pole pieces arranged to eliminate humming noise.

1,504,553. SYSTEM OF CONTROL; A. J. Hall, Winchcombe, England. App. filed July 30, 1920. For electric railway motors.

1,504,563. SUPERVISORY DEVICE FOR AUTOMATIC SPRINKLER SYSTEMS AND THE LIKE; A. J. Loepsinger, Edgewood, R. I. App. filed Nov. 29, 1918. Using a booster pump.

1,504,568. ELECTRICAL PROTECTIVE DEVICE; P. MacGahan, Pittsburgh, Pa. App. filed Dec. 13, 1917. For parallel-connected transmission circuits.

1,504,569. TROLLEY; P. L. Mardis, Swissvale, Pa. App. filed Feb. 4, 1921. May be locked in its inoperative position and automatically isolated from live conductors.

1,504,570. ELECTRICAL SIGNALING; J. O. Mauborgne, Chicago, Ill. App. filed July 26, 1922. To eliminate electrostatic disturbances and other interferences in the reception of radio signals.

1,504,576. TYPEWRITER; E. Pope, Quebec, P. Q., Canada. App. filed Dec. 14, 1922.

1,504,577. SUBMARINE MOTOR-CONTROL SYSTEM AND APPARATUS; L. G. Riley, Wilkinsburg, Pa. App. filed Nov. 23, 1920.

1,504,590. FEED-WIRE CONNECTER; N. J. A. Wahlberg, Pittsburgh, Pa. App. filed May 2, 1919.

1,504,600. MEANS FOR PROTECTING WIRELESS OUTFITS FROM STATIC DISTURBANCES; Q. A. Brackett, Pittsburgh, Pa. App. filed Jan. 16, 1919.

1,504,602. TROLLEY BASE; L. F. Burnham, Wilkinsburg, Pa. App. filed Jan. 20, 1923. Adapted for mine locomotives.

1,504,603. SIGNAL LIGHT; L. W. Chubb, Edgewood Park, Pa. App. filed Jan. 10, 1920. For producing intense flashes of light.

1,504,604. SYSTEM OF CONTROL; L. W. Chubb, Edgewood Park, Pa. App. filed May 24, 1921. Employed in connection with wireless transmission systems.

1,504,606. GRADE CROSSING SIGNAL; J. P. Coleman and Per Utne, Edgewood Borough, Pa. App. filed March 9, 1917.

1,504,609. WEIGHING SCALE; S. G. Crane, Toledo, Ohio. App. filed Nov. 21, 1919.

1,504,611. CURRENT TRANSFORMER; L. Dorfman, Wilkinsburg, Pa. App. filed Nov. 28, 1919. Corrects ratio and phase-angle differences in the currents as the load varies.

1,504,614. ELECTRIC MEASURING INSTRUMENT; C. Le G. Fortescue, Pittsburgh, Pa. App. filed Sept. 1, 1921. For the measurement of the positive or the negative phase-sequence components of unbalanced quantities of an electric circuit.

1,504,621. ELECTRICAL SYSTEM OF DISTRIBUTION; R. E. Hellmund, Swissvale, Pa. App. filed March 31, 1919. System of control for alternating-current railway electrifications.

1,504,622. SYSTEM OF VENTILATION; R. E. Hellmund, Swissvale, Pa. App. filed June 9, 1920. For dynamo-electric machines which have relatively large air gaps, as turbo-generators.

1,504,625. TRANSFORMER; C. G. Jones, Wilkinsburg, Pa. App. filed Aug. 15, 1919. Air blast.

1,504,628. ELECTRIC VALVE; C. L. A. M. Leblanc, Paris, France. App. filed Dec. 16, 1920. For transforming continuous current into single or polyphase alternating currents of any frequency.

1,504,630. WIRE CABLE; C. L. Lilleberg, Chicago, Ill. App. filed Nov. 22, 1922. Means for making connections from wires included in a cable.

1,504,655. ATTACHMENT PLUG; D. N. Thompson, Syracuse, N. Y. App. filed Aug. 25, 1919. Separable.

1,504,691. SAFETY SYSTEM FOR ELECTRIC NETWORKS; M. Höchstadter, The Hague, Switzerland. App. filed Sept. 7, 1921.

1,504,700. ELECTROPLATING APPARATUS; J. L. Mujica, Brooklyn, N. Y. App. filed Aug. 17, 1922.

1,504,711. ELECTRICAL TACHOMETER; H. O. Russell, Detroit, Mich. App. filed March 2, 1922. Based on the rate of change of induced current or voltage in a secondary type of induction coil.

1,504,720. CENTRIFUGAL SHORT-CIRCUITING AND BRUSH-LIFTING DEVICE; F. V. Sams, Milwaukee, Wis. App. filed Aug. 23, 1919. Applicable to automatic control of the circuits of wound-rotor induction motors.

1,504,734. FIELD POLE CONSTRUCTION; R. W. Borchard, Milwaukee, Wis. App. filed June 6, 1921. Fabricated pole end plates.

1,504,788. PRIMARY BATTERY; H. K. Sandell, Chicago, Ill. App. filed Feb. 15, 1923. In which two electrolytes are employed.